COMMITTEE ON ICHTHYOLOGICAL RESEARCH.

REPORT

OF THE

COMMITTEE

APPOINTED TO INQUIRE AND REPORT AS TO
THE BEST MEANS BY WHICH THE STATE OR LOCAL AUTHORITIES
CAN ASSIST SCIENTIFIC RESEARCH AS APPLIED
TO PROBLEMS AFFECTING THE

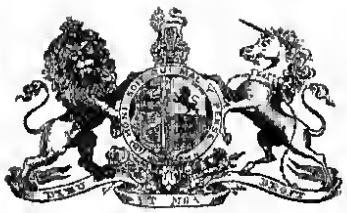
FISHERIES OF GREAT BRITAIN AND IRELAND,

TOGETHER WITH

MINUTES OF EVIDENCE,

APPENDIX, AND INDEX.

Presented to both Houses of Parliament by Command of His Majesty.



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1902.

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MINUTES OF APPOINTMENT.

BOARD OF TRADE, S.W.

At the Council Chamber, Whitehall, this thirteenth day of August 1901.

PRESENT:

The Right Hon. GERALD WILLIAM BALFOUR, M.P.

The Board of Trade are pleased to appoint the following gentlemen, viz. :—

Right Hon. Sir HERBERT MAXWELL, Bart., M.P., F.R.S. (Chairman).
Mr. WALTER E. ARCHER.
Mr. DONALD CRAWFORD.
Rev. WILLIAM SPOTSWOOD GREEN.
Professor WILLIAM ABBOTT HERDMAN, F.R.S.
Hon. T. H. W. PELHAM.
Mr. STEPHEN E. SPRING-RICE, C.B., and
Professor J. ARTHUR THOMSON.

to be a Committee to inquire and report as to the best means by which the State or Local Authorities can assist scientific research as applied to problems affecting the Fisheries of Great Britain and Ireland; and, in particular, whether the object in view would best be attained by the creation of one central Body or Department acting for England, Scotland and Ireland, or by means of separate Departments or Agencies in each of the three countries.

The Board of Trade are further pleased to appoint Mr. R. E. MARTYR to be Secretary to the said Committee.

(Signed) G. W. BALFOUR.

By a subsequent Minute dated 3rd May 1902, the Board of Trade appointed Colonel Sir COLIN CAMPBELL SCOTT-MONCRIEFF, K.C.M.G., C.S.I., R.E., to be Chairman of the Committee *vice* The Right Hon. Sir HERBERT MAXWELL, Bart., M.P., F.R.S., resigned.

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TERMS OF REFERENCE.

To inquire and report as to the best means by which the State or Local Authorities can assist Scientific Research as applied to problems affecting the Fisheries of Great Britain and Ireland, and in particular whether the object in view would best be attained by the creation of one central Body or Department acting for England, Scotland, and Ireland, or by means of separate Departments or Agencies in each of the three countries.

REPORT.

To the Right Hon. Gerald William Balfour, M.P., President of the Board of Trade.

Sir,

The Board of Trade by their Minute of the 13th August, 1901, were pleased to appoint this Committee—"to inquire and report as to the best means by which the State or Local Authorities can assist scientific research as applied to problems affecting the Fisheries of Great Britain and Ireland; and, in particular, whether the object in view would best be attained by the creation of one central Body or Department acting for England, Scotland and Ireland, or by means of separate Departments or Agencies in each of the three countries."

In taking evidence on the subject matter of the Inquiry the Committee have had the advantage of examining officers of the Fisheries and Harbour Department of the Board of Trade, the Fishery Board for Scotland, and the Fisheries Branch of the Department of Agriculture and Technical Instruction for Ireland.

The Committee have also been favoured with the views of a number of other experts such as Professor E. Ray Lankester, F.R.S., Professor W. C. M'Intosh, F.R.S., of the Gatty Marine Laboratory, St. Andrews, Dr. Noël Paton, of Edinburgh, Dr. J. T. Jenkins, of Hartley College, Southampton, Mr. J. T. Cunningham, Lecturer to the Technical Instruction Committee of Cornwall, and Messrs. E. J. Allen and W. Garstang of the Marine Biological Association.

Captain Tizard, R.N., Assistant Hydrographer to the Admiralty, and Dr. H. R. Mill, Director of the British Rainfall Organisation, have given the Committee valuable information with respect to hydrographical investigations in the North Sea, and representatives of some of the Local Fisheries Committees and Universities on the English and Welsh Coasts have also been examined.

Among other witnesses were Mr. J. A. Travers, of the Fishmongers' Company; Mr. J. H. Barber, Secretary of the Chamber of Fisheries; and gentlemen with such practical acquaintance with Fishery work as Mr. G. L. Alward, of Grimsby, and Mr. R. A. Dawson, the Superintendent of the Lancashire and Western Sea Fisheries District.

Professor Howes, F.R.S., of the Royal College of Science, and Mr. G. C. Bompas also favoured the Committee with information regarding the origin and present condition of the Buckland Fish Museum at South Kensington.

The Committee have now the honour to submit the following Report:—

I. CONSTITUTION AND POWERS OF SEA FISHERIES AUTHORITIES IN THE UNITED KINGDOM.

Central Fishery Authority in England and Wales.

1. In England and Wales the Board of Trade is the Central Fishery Authority responsible for the administration of the Acts relating to both Sea Fisheries and Salmon and Freshwater Fisheries, while, as hereafter explained, Local Fisheries Committees are charged, under the control of the same Board, with the regulation of the Sea Fisheries carried on within the limits of their districts. The Fisheries and Harbour Department of the Board of Trade is under the charge of an Assistant Secretary, and the Expert Staff consists of one Chief Inspector and two Inspectors of Fisheries.

2. The Board of Trade have lately given increased attention to the collection of statistics of fish landed at the different ports of En land and Wales, and,

for the purpose of giving effect to certain recommendations of a Departmental Committee which they had appointed to inquire and report on the matter, they have strengthened the staff of collectors at Hull and Grimsby and are endeavouring to obtain more accurate and extended returns from these and other important fishing ports on the east coast. Full particulars of the system now commenced and proposed to be carried out is given in a Memorandum appended to this Report.*

3. Apart from the annual vote for the salaries of the Staff of the Fisheries and Harbour Department, the only special provision made by Parliament to the Board of Trade for fishery purposes is the grant of 1,600*l.* for the collection of Statistics, and of 100*l.* to meet incidental expenses under the Sea Fisheries Acts. The Fishery Inspectors present annual reports, which, according to the Acts, are required to contain, as far as practicable, a statistical account of all Salmon, Freshwater, and Sea fisheries over which the Board of Trade have jurisdiction or control, with such other information as may be collected, and suggestions offered for their regulation and improvement. No provision is made for the conduct of scientific investigations, although fully to carry out the statutory duties laid upon the Board and their Inspectors would necessarily involve Ichthyological research.

24 & 25 Vict., c. 109.
49 & 50 Vict., c. 39.

Local Fisheries Committees in England and Wales.

51 & 52 Vict., c. 54.

4. In England and Wales the Acts relating to Sea Fisheries are, to a great extent, carried out by Local Sea Fisheries Committees. They are formed by Orders made by the Board of Trade under the Sea Fisheries Regulation Act, 1888, and consist of a Committee of a County or Borough Council or a Joint Committee of two or more of those Councils, with the addition of at least an equal number of members representing the fishing interests of the District, who are appointed by the Board of Trade.

One of the principal duties discharged by these Committees is the making and enforcing of bye-laws for the protection and regulation of the sea and shell fisheries within their Districts, but these bye-laws do not become operative until they have been confirmed by the Board of Trade. In cases where objections to bye-laws are received by that Board a local inquiry is generally held by one of the Inspectors of Fisheries.

The expenses of a Local Committee are paid out of the County or Borough Funds in the proportion specified in the Order creating the District.

There are twelve Sea Fisheries Districts covering the whole of the coast and territorial waters of England and Wales, with the exception of the Bristol Channel and the portion of the East Coast lying between Happisburgh and Dovercourt. In addition, the powers of a Local Fisheries Committee have been granted under various Orders made by the Board of Trade to thirty-seven Boards of Conservators of Salmon Fishery Districts in respect of so much of the rivers and estuaries within these Districts as lie above certain specified lines, and to the Board of Conservators of the Suffolk and Essex Salmon Fishery District in respect of the coast and territorial waters lying between Covehithe, near Southwold, and Dovercourt. The Southampton Harbour Board and the Corporation of Colchester also possess the powers of a Local Fisheries Committee within the areas under their jurisdiction.

57 & 58 Vict., c. 26.

5. Under Section 1 of the Sea Fisheries (Shell Fish) Regulation Act, 1894, a Local Fisheries Committee is empowered to stock any public fishery for shell fish and, for that purpose, to incur such expenses as may be sanctioned by the Board of Trade, but, apart from this provision, they are not authorised to expend any portion of their funds in fishery investigations.

Under the Sea Fisheries Regulation Act, 1888, these Committees are to "collect such statistics . . . as the Board of Trade may reasonably "require," the expenses thereof to be borne by moneys provided by Parliament; but, apart from the annual returns rendered to the Board of Trade, in connection with which no expense to Imperial Funds is incurred, no demand has been made upon the Committees for special information involving public expenditure.

Nevertheless, in consequence of assistance rendered by certain County Councils, fishery investigations of a scientific character are carried on in

* *See* p. xxi.

several districts. The work performed by the Committee for the Lancashire and Western District under the chairmanship of Mr. John Fell is particularly noticeable. That District is the largest in the country, and extends from the River Duddon—in the North—to Cemmaes Head in Cardigan Bay, in the South. Owing to the exceptional advantage enjoyed by the Committee with regard to the rateable value of Lancashire, the proportion of the expenses paid by the contributing authorities does not exceed 1-16th of a penny in the pound. The Committee, out of the funds at their disposal, maintain a steamer, partly employed in police duty and partly in research work, and they have also, with the assent of the Board of Trade, expended the sum of 1,000*l.* in the establishment of a Lobster Hatchery and Marine Station at Piel, near Barrow-in-Furness The expenditure of a further annual sum not exceeding 500*l.* has been sanctioned for ten years for the maintenance and working expenses of the hatchery and its adjuncts.

6. A fish hatchery and marine laboratory for scientific work will shortly be opened at Port Erin, partly at the cost of the Isle of Man Government, and partly at the cost of the Liverpool Marine Biology Committee (established in 1887), in the work of which that Committee and a Manx Government Committee will co-operate.

The Liverpool and the Lancashire and Western Committees are further associated in fishery investigations at the zoological laboratory of University College, Liverpool. The Lancashire and Western Committee has published, among other papers, eleven annual reports on its scientific work and certain valuable monographs. In addition to these local researches, the Lancashire County Council has instituted laboratory classes for fishermen and has, for some years, circulated in the county a travelling Fisheries Museum. A detailed scheme for the investigation of the Irish Sea, brought before the Committee by Professor Herdman, is given in Appendix I.

A Laboratory and Marine Station has been established at Cullercoats, in the Northumberland Sea Fisheries District, mainly owing to the assistance given by Mr. John Deut, a member of the Local Committee. Experimental trawlings have been carried on for ten years, and some valuable experiments with regard to the practicability of fertilizing fish ova at sea have been made.

Other Fisheries Committees possess small Marine Stations and, with the assistance and collaboration of the Technical Instruction Committees of littoral County Councils, have instituted classes and lectures for fishermen; but the means at their disposal are extremely limited and little or no scientific investigation is undertaken.

Marine Biological Association.

7. A Laboratory for the purpose, amongst other objects, of carrying out sea fishery investigations has been established at Plymouth by the Marine Biological Association of the United Kingdom. It was opened in 1888 and was constructed at a cost of 12,000*l.*, of which amount 5,000*l.* was received as a grant from H.M. Treasury.

H.M. Government has made to the Association annual grants of 500*l.* during the years 1888-1890, and of 1,000*l.* a year since that date. The annual income of the Association in 1900-1 amounted to about 1,700*l.* One of the conditions attached to the annual grant from the Treasury was that space at the Plymouth Laboratory should be placed at the disposal of any competent investigator deputed by a recognised authority to carry out investigations into fishery questions. In the absence of funds for such investigations the Board of Trade have not availed themselves of this condition, neither have the Scottish or Irish Fishery Departments deputed persons to conduct investigations at the Laboratory. The principal part of the funds is absorbed in the maintenance of the laboratory, aquarium, and boats at Plymouth, a little over 500*l.* being all that is available for the employment of naturalists. The Association recently purchased the s.s. "Oithona," of 84 feet length and of 16 feet beam, by means of which investigations are conducted on the south coast.

Central Fishery Authority in Scotland.
48 Geo. III. c. 110.
45 & 46 Vict. c. 78.
52 & 53 Vict. c. 23.
58 & 59 Vict. c. 42.

8. The authority entrusted with the management of the Sea Fisheries in Scotland is the Fishery Board, which was created by the Herring Fishery Act, 1808, "for the further encouragement and better regulation of the British White Herring Fishery," and re-constituted under the Sea Fisheries Acts (Scotland) of 1882, 1889, and 1895.

In addition to the indoor staff of the Board there is an outdoor department, including an Inspector of Salmon Fisheries, a General and an Assistant Inspector of Sea Fisheries, and 32 Sea Fishery Officers, five of the latter assisting at the more important fishery stations.

For the purpose of Sea Fisheries, Scotland is divided into 27 districts, and the duties of the Sea Fishery Officers in charge of the districts include the collection, principally through the agency of local correspondents, of statistics of the quantity and value of sea fish landed on the Scottish coast, which statistics are collated at the head office. A sum of 730*l.* per annum is granted by the Treasury for allowance to the fishery correspondents.

The vote for the Fishery Board for Scotland for 1902–3 amounts to 18,097*l.* 1,327*l.* of this represents the surplus of the Herring Brand Fees received by the Board, while provision is made in other estimates for expenditure in respect of office accommodation, rates, printing, &c., to the amount of 2,903*l.* The Herring Brand Fees form a very fluctuating source of revenue, the cost of branding sometimes even exceeding the income derived from it.

The estimated expenditure on scientific investigation during the current year is 770*l.* as compared with 2,770*l.* in 1901–2, the decrease, it is understood, being due to the fact that the sum of 2,000*l.* formerly granted to the Fishery Board under this head, will be withheld for the period of three years during which H.M. Government have agreed to participate in the International Scheme of Fishery Research in the North Sea.

Considerable expense is also incurred in the collection of fishery statistics, and Dr. T. Wemyss Fulton, the Superintendent of the Scientific Investigations, is engaged in collecting valuable information from Commercial Trawlers with regard to the place of capture of fish landed at Aberdeen.

9. Scientific research and sea-fish hatching have been carried out at the Marine Laboratory on the Bay of Nigg, Aberdeen, and instruction to fishermen has been given there in consideration of a grant of 200*l.* from the Technical Education Committee. The investigations and trawling experiments have been much hampered and restricted owing to the small size and inefficiency of the "Garland," a steam yacht in the service of the Fishery Board, which has been sold as no longer seaworthy. The other vessels owned or at the disposal of the Board are wholly occupied with police work and are not available for scientific investigations.

Steam trawlers within the Moray Firth or other parts of Scottish territorial waters have been occasionally made use of by the Fishery Board for scientific purposes, and a number of trips were made during 1900–2.

As regards Salmon Fisheries, the Inspector is continuing investigations into the life-history of the salmon.

58 & 59 Vict. c. 42

By the Sea Fisheries Regulation (Scotland) Act, 1895, provision was made for the establishment of Sea Fishery District Committees as in England, with considerable powers of regulation, to be exercised by the Fishery Board, in respect of any part of Scotland where there was no District Committee. The expenses of the District Committees were to be defrayed by a rate assessed on the counties, burghs, or police burghs, with the consent of the County Councils, Town Councils, or Police Commissioners of such counties, burghs, or police burghs. No District Committee has yet been established.

Besides the investigations carried on under official recognition, a certain amount of work bearing on fishery problems has been done and is being done in university and other laboratories, notably at the Gatty Marine Laboratory at St. Andrews by Professor M'Intosh and his school of investigators.

Central Fishery Authority in Ireland.

10. The Office of Irish Fisheries is now merged in the Department of Agriculture and Technical Instruction for Ireland. The expert staff as regards Fisheries consists of one Chief Inspector, one Inspector, and, as a temporary arrangement, of a scientific adviser and two assistant naturalists.

Under Section 16 of the Agricultural and Technical Instruction (Ireland) Act, 1899, the annual sum of 10,000*l.* is to be applied for the purpose of Sea Fisheries, and such surplus of any monies placed at the disposal of the Department under Part II. of the Act as the Department think fit to allot may also be applied to the same purpose. 62 & 63 Vict. c. 50.

This annual subsidy enabled the Department to purchase (in October, 1900) the steam cruiser "Helga," her dimensions being—length 150 feet, beam 23 feet, and draught 10 feet 6 inches.

The "Helga" has been engaged in police duties and in investigations bearing on the life history of food fishes, in surveys of Oyster grounds with a view to the resuscitation of the industry, and in other scientific work. She is now fully equipped for fishery research in deep or shallow water.

11. In the Report of the Scientific Adviser, appended to the Report on the Sea Fisheries of Ireland for 1900, it is stated that, since February, 1899, the Royal Dublin Society, with the assistance of a grant from H.M. Treasury, have been engaged in fishery investigations on the west coast of Ireland. For this purpose a hulk of about 200 tons was converted into a floating laboratory and houseboat, and provided with a fully equipped mackerel drift-net boat of 22 tons and a flotilla of smaller boats. The investigations instituted by the Society were designed to extend over a period of five years. By arrangement with the Society, the Laboratory has now been taken over by the Department of Agriculture and Technical Instruction, subject, as to the conduct of certain investigations, to the control of a Joint Committee of the two bodies. The Laboratory is stationed in Fahy Bay, a sheltered anchorage near Cleggan, Co. Galway, which is the head-quarters of a large mackerel fishery. The principal subjects of inquiry are (1) the Life History of the Mackerel and (2) the Marine Life History of the Salmon.

12. To sum up the foregoing—

Summary of Scientific Investigations now carried on within the United Kingdom.

(*a*) In England and Wales, the Central Fishery Authority—the Board of Trade—collect fishery statistics, for which a special grant is made by the Treasury. It is not, however, directly provided with funds for Scientific Research, although the Inspectors are charged with the duty of offering suggestions for the regulation and improvement of the fisheries. Research work, chiefly affecting local problems, is undertaken by a few of the Sea Fisheries Committees and by one or two scientific bodies, *e.g.*, by the Committees for the Lancashire and Western and the Northumberland Sea Fisheries Districts respectively, and by the Marine Biological Association, which is the only unofficial body in England and Wales in receipt of State aid in connection with fisheries work.

(*b*) In Scotland and Ireland Scientific Research is undertaken at the cost of the State by the Central Fishery Authorities for those countries, the valuable work done by the Fishery Board for Scotland being hampered and restricted by the want of an efficient seagoing steamer, a disadvantage in which Ireland does not participate, as that country possesses, in the "Helga," a vessel well fitted for research work.

II. PROBLEMS TO BE INVESTIGATED AND METHODS REQUISITE FOR THEIR SOLUTION.

Fishery problems and methods suggested for their solution.

13. Having thus described the existing Fishery Authorities in the United Kingdom and indicated the scope of the Scientific Investigations undertaken by them, the Committee would propose briefly to state what in their opinion are the chief problems affecting the sea fisheries of this country the solution of which it is desirable to assist, and then to suggest methods to be adopted for their solution.

14. These problems, as concerning not only Great Britain but the other countries bordering on the North Sea, have been the subject of two International Conferences, held in 1899 and 1901, at Stockholm and Christiania respectively. The attention of the Committee has naturally been drawn to the schemes proposed at these Conferences, and much evidence has been taken, more particularly with regard to the bearing of the Christiania programme on fishery problems. From this evidence it appears that that scheme, in the opinion of some of those who have had most experience in such work, would not give the information required by this country. But since the consideration of this particular question involved points of a technical nature, the members of the Committee who possessed the most scientific and special knowledge of the subject were asked by their colleagues to prepare a Memorandum which might be laid before the Board of Trade in time to allow of any additions or amendments being made to the instructions then about to be given to the British delegates at the first meeting of the International Council at Copenhagen.

15. To the principles contained in this Memorandum, which was forwarded to the President of the Board of Trade on the 8th July, the Committee attach great importance, and they therefore append the document in full to this Report.* And as the recommendations which the Committee have to make in regard to any scheme of Sea Fishery Research, whether national or international, in which this country may participate, are based largely on a similar line of argument to that made use of in the Memorandum, it will be useful to recapitulate the principal points and to indicate what seem to be the best means of carrying them out.

The most pressing problems to be solved.

16. There are many problems, but the fundamental practical problem at the present time is to establish the fact of an increased or decreased yield of the fisheries within the available area of supply, and the most pressing part of this problem relates to the more sedentary and local fish, such as flat fish.

If a decrease of a serious and progressive nature is established one has to consider whether such decrease is due to natural causes or to man's operations.

If to the latter, one needs to know in which localities, and at what seasons, particular kinds of fishing cause such decrease.

There is also the further problem of how fishing can best be regulated so as to afford protection to food fish.

The method requisite for the solution of these problems.

17. To establish the fact of an increase or decrease of the fisheries, information must be obtained as to the amount of fish caught on particular grounds by vessels sufficiently numerous to supply data representative of the total yield.

In this connection the Committee would point out that it would be incorrect to assume that the take of a single vessel will lead to definite conclusions as to the number of fish in a given area at different times irrespective of any fluctuations in the number of other vessels which may be at work in the area. This objection applies equally whether the area investigated is closed to commercial fishing vessels or not. For since fish may migrate from one fishing ground to another, as is shown by the experiments made in the Firth of Forth, their abundance may be affected not only by the fishing in the closed area, but also by that in adjacent waters.

In these circumstances provision should be made at the principal fishing ports for the collection of statistics shewing the quantity of fish landed, and the places at which they were caught, from a large number of vessels, as suggested above. This might be done, as regards England by the staff proposed by the Inter-Departmental Committee on Fishery Statistics, if the recommendations of that Committee were carried out in their entirety, with the addition of the special returns to be referred to in paragraph 20.

18. To ascertain the physical conditions under which fish live, as well as the distribution of fish food, fish eggs, and fish during their different stages of

* *See* p. xxii.

growth, samples must be taken. Samples would include the raw material, whether collected by commercial fishing boats, special steamers, or other means, and also observations on the chemical and physical conditions affecting fish and their surroundings.

It follows that any scheme of research, however elaborately planned or carefully carried out, will fail in its object if the samples are not taken over a sufficiently large area, and at sufficiently frequent intervals, to be truly representative of the area and period which they are supposed to represent.

To determine at what intervals of space and time samples must be taken in order that they may be representative of a given area and period, numerous observations must be made to show how far the conditions are uniform.

19. There seem to be three possible ways of obtaining the necessary data :—

(*a*) by the detailed study of some comparatively limited areas where it is possible to cover the ground so closely and so frequently that trustworthy conclusions as to the population may be reached in a few years ; or

(*b*) by utilising the material obtainable from a large number of commercial trawlers operating on a large area ; or

(*c*) by means of a large fleet of special steamers working continuously with scientific methods over a large area for a term of years.

Each of these three methods has its obvious limitations and drawbacks, and a combination seems to us the most desirable plan of action.

20. The main features with regard to the size, description, condition and food of fish taken in a particular area should be determined by an examination at the port of landing of the fish brought ashore by the commercial fishing vessels. To enable this to be done provision should be made for the payment of masters of fishing vessels for filling up returns, and also of a staff of trained assistants to deal with these returns and to examine fish landed. It would be necessary to give compensation for any depreciation in the value of the fish resulting from such examination.

Special steamers.

21. The more thorough exploration of any particular ground can best be undertaken by a special steamer working continuously for a prolonged period on that ground ; and all the coastal waters of the United Kingdom ought in course of time to be surveyed in that manner. As has been shown, in the historical part of this Report, the Irish authorities and the Marine Biological Association have steamers capable of doing such work off the coast of Ireland and in the English Channel respectively. Three additional steamers, however, would be required if a complete system of investigations is to be carried out—one, for work in connection with a laboratory to be established and maintained at some central position on the east coast of England such as Grimsby ; a second, for work along the west coast and in the Irish Sea, in connection with the Liverpool Laboratory ; and a third in Scotland to replace the "Garland." The steamers for England should be under the control of the proposed Fisheries Council for England, and that for Scotland under the control of the Fishery Board for Scotland.

Staff at laboratories.

22. To enable the material thus collected to be dealt with, a staff of workers would be required at each of the above-mentioned laboratories. It is suggested that this should consist of three biological assistants at each of the three laboratories in England (Plymouth, Grimsby, and Liverpool), in addition to those in Scotland and Ireland,—the scientific staffs in each case being placed on a permanent basis. A scientific assistant at the head-quarters in London to keep a register of the observations, and a storekeeper and other subordinate assistants for work in connection with the special steamers would also be necessary.

Experimental regulation of fishing operations.

23. In view of the difficulty of carrying out at a reasonable cost any reliable investigations as to the effect of natural causes on the abundance of fish, and the danger of partial results referred to in the special memorandum by some Members of the Committee, appended to this Report,* the Committee

* *See* p. xxii.

consider that the effect of man's operations on the fisheries can best be tested by regulating such operations experimentally. In making this recommendation they are not unmindful of the international difficulties in the way of imposing restrictions beyond territorial waters.

Other fishery problems.

24. In addition to such pressing problems connected with our trawling industries, there are, also, many others of a like nature, some connected with shell fish, such as oysters, mussels or lobsters, some connected with migratory fish such as the herring or mackerel, and similar problems, which could be investigated from the laboratories mentioned above, by means of the special steamers, the scientific staff recommended, and the results obtained from the commercial fishing vessels.

III. AUTHORITIES FOR CONDUCTING AND CONTROLLING INVESTIGATIONS.

Authorities for conducting and controlling Investigations.

25. The Committee have now to consider the question who should conduct and control the investigations which they have recommended for adoption and, in particular, whether there should for this purpose be one central body or department acting for England, Scotland and Ireland, or separate departments or agencies in each of the three countries.

It will be gathered from the previous parts of this Report that in Scotland and Ireland certain scientific investigations are conducted by the Central Authorities at Edinburgh and Dublin respectively, who are also responsible for the administration of the laws and regulations relating to Sea Fisheries in those parts of the United Kingdom.

In England, on the other hand, where fishery administration is conducted partly by the Central Authority (the Board of Trade) and partly by the local Sea Fisheries Committees, no funds have been allocated to them for scientific research, apart from the special grant made to the Board of Trade for the collection of fishery statistics. A certain amount of research work is, however, undertaken by some of the Local Fisheries Committees and an annual grant of 1,000*l.* is made by Parliament to the Marine Biological Association.

26. There might, no doubt, be some advantage in having one Central Department for conducting all scientific investigations affecting fisheries in the United Kingdom, so as to ensure the adoption of one uniform system. The Committee, however, are compelled to recognise the existence of separate departments in the three countries for the administration of fishery laws and the collection of statistics; and from the evidence submitted to them they are convinced that, as far as possible, scientific investigations into questions affecting fisheries should be conducted or controlled by the Authorities who are responsible for the administration of the fishery laws and who are more or less in touch with those engaged in the trade. It is important also, that the authority which is ultimately responsible for restrictions on the times and modes in which fish may be taken, should be in a position to test the efficacy of such restrictions.

27. Further, the Committee are of opinion that, inasmuch as the question of the increase and decrease of the fisheries forms an important part of any scheme of fishery research, it is desirable that the investigations should be controlled by the authority responsible for the collection of fishery statistics.

In these circumstances the Committee are not prepared to recommend the creation of one Central Department for Ichthyological research in England, Scotland and Ireland, though they have certain suggestions to make hereafter as to the formation of a Conference of Experts representing the three countries.

Scotland and Ireland.

28. As regards Scotland and Ireland, the Committee see no sufficient reason for suggesting any alteration as to the Authority who should conduct

scientific investigations, namely, the Fishery Board in Scotland, and the Department of Agriculture in Ireland, which two Authorities are also responsible for the administration of the fishery laws and the collection of fishery statistics. In neither of these two countries are there at present local Sea Fisheries Authorities as in England.

England and Wales.

29. In considering the question as to what authority or authorities should conduct scientific investigations in England and Wales, it is important to bear in mind—

(*a*) that the Board of Trade, as the Central Authority, are ultimately responsible for the administration of the fishery laws and the collection of statistics; and that the Inspectors of Fisheries are responsible for making suggestions for the regulation and improvement of the fisheries;

(*b*) that there are twelve or more Local Fisheries Committees who, subject to the control of the Board of Trade, administer certain of the laws relating to fisheries in territorial waters within their districts;

(*c*) that two or three of these Local Authorities conduct investigations on their own account;

(*d*) that the only grant-in-aid of such work is made to the Marine Biological Association of the United Kingdom, who possess a steam vessel and a laboratory;

(*e*) that the fishery interests of the East Coast, the South Coast and the West Coast of England, respectively, are, to some extent, distinct; and

(*f*) that the fish landed at East Coast ports in England far exceed in quantity and value the fish brought into all the other ports of the United Kingdom.

30. Having regard to all these considerations the Committee are of opinion that although the control of the investigations should be vested in a Central Authority, as is the case in Scotland and Ireland, yet provision should be made for the delegation of the powers to conduct such investigations to certain Local Authorities or Bodies who may be found to be capable and willing to undertake the same, and to contribute from their funds to the cost thereof. At the same time, the Committee, as hereafter pointed out, think that the Local Bodies who conduct such investigations and contribute to the cost thereof, are entitled to some representation on the proposed Fishery Council for England, while the Central Authority should exercise a general control, in consideration of which a grant of public money might be allocated to the Local Bodies.

In the same way any grants of public money made to the Marine Biological Association should be made conditional on investigations being carried out on the lines laid down by the Fishery Council, on which Body the Association will be represented.

The Lancashire and Western Fisheries Committee and the Marine Biological Association would probably be able, with the proposed financial assistance, to conduct all the necessary investigations on the west and the south coasts of England, and it might be found desirable to delegate similar powers to other District Committees or Institutions on the east coast, in consideration of grants of public money, if any such bodies should, at any time, be found willing and capable to undertake the duty.

In short, the view of the Committee is that the Central Authority in England should have control over all sea fishery investigations as is now the case in Scotland and Ireland, but that, in certain instances, the actual carrying out of the investigations should be delegated to Local Bodies. It will be desirable that the Sea Fisheries Committees should receive statutory power to expend money on research work, subject to such limitations and control as may be found necessary.

31. But it must be remembered, as already stated, that while by far the most important fisheries of England are those connected with ports on the east

coast, it is on this coast that the least effort has been made to carry out investigations on a systematic scale.

Grimsby and Hull, the two largest fishing ports, are within the District of the North Eastern Fisheries Committee, but a large proportion of the fish caught by the Hull Fleet is landed in London, which is not within any Sea Fisheries District; while the Local Fisheries Authorities between Grimsby and Ramsgate are not much interested in the larger questions which would affect the supply of fish at Grimsby, Hull, or London. Each of these Local Authorities have their own special interests, and for administrative purposes it would probably not be found convenient to amalgamate them. Moreover, some of the problems concern other countries bordering on the North Sea, which problems it may from time to time be found desirable to investigate on some common plan. Considering, therefore, the exceptional importance of the fisheries on the east coast, it would seem expedient that the Central Authority should themselves conduct the principal investigations on that coast.

It must not, however, be understood that the Committee consider that the whole expense of the investigations on the East Coast should be borne by the National Exchequer. On the contrary, they think that these expenses might be met by contributions from those interested in the trade. For instance, London, Grimsby, and Hull might reasonably be expected to provide funds towards an object in which they are so deeply interested.

Constitution of Council for Fishery Research in England.

32. Having regard to their recommendation that fishery investigations in England should be controlled by the Central Authority, but that provision should be made for the actual operations being carried out where possible by Local Bodies, the Committee have had to give special consideration to the constitution of the Body by whom such central control should be exercised in order to secure efficiency and to prevent waste of power.

As already stated, it seems to the Committee desirable that those who undertake the local investigations should be represented on the Central Authority, and they think that such representation might be effected by the Board of Trade constituting a Council for Fishery Research in England (which might be known as the Fishery Council for England). It is suggested that, in addition to one or more representatives of the Expert Staff of the Fisheries Department, this Council should consist of persons some of whom are conducting Scientific Investigations relating to fisheries, and some of whom are engaged in fishery administration.

The West Coast of England might be represented by the Director or other expert officer of the Liverpool Laboratory; and by a member of one of the Sea Fisheries Committees of that coast, selected by those Committees who contribute to the expenses of investigations.

In the same way, the South Coast of England might be represented by the Director or other expert officer of the Laboratory of the Marine Biological Association; and by a member of one of the Sea Fisheries Committees of that coast, selected by those Committees who contribute to the expenses.

The Sea Fisheries Committees on the East Coast, if willing to make a contribution, could similarly send their representative from amongst their own members, and whenever a laboratory is established at any place on that coast, which the Board of Trade think is qualified to be represented, the Director or other expert officer of the laboratory should be a member of the Council.

Each of the three coasts would thus be represented by one expert, and one administrative member, and these six members, with such representative or representatives as the Board of Trade may appoint, would form the Council for Fishery Research in England.

It may be necessary that the Board of Trade should have power to nominate a representative of the Local Fisheries Committees, where the Committees fail to agree amongst themselves as to their representative, or where no contributions are received from any Committee.

33. The Council should meet once a quarter, or once a month, as occasion may require, and the local members attending the meetings should be paid their travelling and maintenance expenses.

The duties of the Council should, in the opinion of the Committee, be as follows:—

(*a*) to formulate schemes of investigation to be carried out by the Central Authority or Local Bodies, and to receive their reports;

(*b*) to recommend to the Board of Trade the proportions in which any sum voted by Parliament for the purpose should be allocated to the different bodies;

(*c*) to report from time to time to the Board of Trade as to the results of the various investigations made by the different bodies; and

(*d*) generally to exercise control over the investigations with a view to efficiency and uniformity of action.

The Committee would also suggest that the Council might, in particular cases, entrust the investigation of specific problems to workers in laboratories which have no official connection with the Council.

Any recommendations made by the Council involving expenditure by the Central Authority would have to be carried out by and on the responsibility of the Board of Trade.

The Board of Trade, as the Statutory Body for administering the Acts relating to Sea Fisheries, would remain responsible to the Crown and Parliament for such administration and for the expenditure of all public money in connection therewith.

Conference of representatives from the three Kingdoms.

34. In order to secure uniformity of action between the different bodies conducting Scientific Investigations in England, Scotland and Ireland respectively, to prevent overlapping of areas, and, in the case of investigations conducted in co-operation with foreign countries, to arrange how the work is to be divided between the three different bodies, the Committee are of opinion that there should be a Conference of expert members for the United Kingdom.

It is suggested that the Fishery Council for England should nominate four of their members and the Fishery Board for Scotland and the Irish Fishery Department should each nominate two of their members to attend such Conference, which should hold meetings once a quarter.

The meetings of this Conference would give an opportunity to the members of the three Central Authorities to compare notes, to obtain information as to what is being done in the three countries, and to make suggestions to the three Central Authorities as to what particular work should be undertaken by each.

It is not suggested that the Conference should themselves undertake any work of investigation.

IV. FISHERY MUSEUM.

Buckland Fish Museum.

35. The biological and practical witnesses examined on the point are unanimous in their expression of opinion as to the advantage of the formation of a national or central Fishery Museum, and it has been urged that the nucleus for such a museum exists in the Buckland Fish Museum now at South Kensington. This collection was originally formed by Mr. Frank Buckland, one of H.M. Inspectors of Fisheries, who died in 1880 and bequeathed his collection to the nation "upon trust that the same may under the name of "'Buckland's Fish Museum' be for ever devoted to the use of the nation "and form part of the National Collection at the South Kensington Museum "for public instruction and enjoyment under the regulation of the authorities "for the time being having the direction or control of the said last men-"tioned museum." He further bequeathed the sum of 5,000*l.* (now, through default of a Trustee 4,500*l.*) to found (after his widow's death) a Professorship of Economic Fish Culture in connection with his museum. The gift

and its conditions were accepted by the Science and Art Department in 1881, and notwithstanding the recommendations of a Departmental Committee in 1889 and the Select Committee on Museums of the Science and Art Department of 1898, in favour of the abolition of the Buckland Fish Museum as a separate exhibit, the collection still forms a distinctive part of the exhibits at the Victoria and Albert Museum. A collection of British fish which has been added to the Buckland Collection is sometimes used by Professor Howes for the purpose of illustrating his lectures to Natural History Students at the Royal College of Science, and to some extent also the Trout hatchery tanks forming part of the Exhibits are of service; but it is admitted by the witnesses having practical knowledge of the collection that, although it affords a useful nucleus for a fishery museum, the bulk of the exhibits are either out of date or of little value.

The Committee are of opinion that it would be desirable, not only for purposes of record and research, but also for the technical instruction of fishermen that a central fishery museum should be established.

It is obvious that such a museum would be of most service to fishermen if it were to form part of a Marine Laboratory at a fishing centre, and the Committee venture to express the opinion that, looking to the present condition of the Fishery Collection at South Kensington, greater advantages would accrue to the objects Mr. Frank Buckland had in view and his wishes would be better carried out, if his monetary bequest were applied to the establishment at a place on the east coast, say at Grimsby, of a National Laboratory and Museum worked under the control of the Central Authority.

Rooms could be set apart in the building for museum purposes, in which such specimens in the present fishery collection at South Kensington as are worth preserving could be exhibited, and which would form the nucleus of a National Fishery Museum. The whole could be named the "Buckland Laboratory and Fish Museum."

V. SALMON FISHERIES.

Salmon Fisheries Commissions.

36. In view of the Report of the Royal Commission on Salmon Fisheries recently issued, as well as that of the Vice-regal Commission which made recommendations relating to the Inland Fisheries of Ireland, the Committee do not consider it desirable to go into the question of scientific research with regard to inland fisheries.

They feel that their recommendations can be made applicable to such fisheries if due regard be paid, in constituting the Fishery Council for England, to the selection of one or more representatives interested in the salmon fisheries.

VI.—SUMMARY OF RECOMMENDATIONS.

Summary of recommendations.

37. The Committee would now close their Report by briefly summing up the recommendations which they have made.

(i.) Provision should be made at the principal Fishing Ports of the United Kingdom for the collection of Statistics, on the largest scale practicable, for the purpose of ascertaining the particulars of the fish landed and the place where they were caught. To carry this out, provision should be made for the payment of masters of fishing vessels for filling up returns, and of a staff of trained assistants to deal with these returns and with the samples landed and selected for examination, and for incidental expenses.

See paras. 17—20.

See para. 21–23.

(ii.) In addition to the research vessels possessed by the Central Authority in Ireland and by the Marine Biological Association at Plymouth, three special steamers should be provided to study definite sea areas. One of these vessels should work on the east coast, a second along the west coast of England, and the third should replace the "Garland" on the coasts of Scotland. Each of the steamers should work in connection with a Biological laboratory. Each of the laboratories (in addition to those already established

in Scotland and Ireland), should have three biological assistants, and another assistant should also be stationed at the office of the Central Authority in each country. It is understood that the existing laboratories at Liverpool and Port Erin would meet the wants of the west coast, and that at Plymouth those of the south coast. It would be necessary to establish a new laboratory at some central point on the east coast of England.

(iii.) While the Committee see no sufficient reason for suggesting any changes as to the Central Authority for conducting Scientific fishery investigations in Scotland and Ireland, they consider that the functions of the Fisheries and Harbour Department of the Board of Trade, which is the Central Authority for England, should be considerably enlarged. They recommend that the Board of Trade should have power not only to delegate to any satisfactory local fishery authority the conduct of such fishery investigations as the latter body are willing and able to carry out, but also themselves to conduct investigations. The local fishery authorities, and the Authorities or Bodies who conduct or contribute to the expense of such investigations, should be represented on the central Fishery Council at the Board of Trade, which Council should have general control over all such investigations, and should be constituted as hereafter stated. See paras 28 - 30

(iv.) The Committee recommend that statutory powers be given to the Local Sea Fisheries Committees to expend money on fishery research. See para. 30

(v.) The Committee, recognising that on the East Coast of England, except to a small extent in Northumberland, there are no Local Fisheries Committees contributing to the knowledge of fishery problems, recommend that the Fishery Council for England itself should conduct investigations on that coast. The Committee think, however, that if possible the expenses of such investigations should be partly borne by those who are pecuniarily interested in them. See para. 31

(vi.) The Committee recommend that a Fishery Council for England should be constituted at the Board of Trade, consisting of official and other representatives as recommended in paragraph 32. This council should meet periodically to formulate schemes of investigation, to make recommendations as regards Government grants, to report on the knowledge acquired by the researches made, and generally to exercise control of the investigations. See para. 32.

(vii.) In order to secure uniformity of action between scientific bodies at work in the seas surrounding the United Kingdom, and to prevent overlapping of areas of research, the Committee recommend that there should be a Conference, consisting of representatives of the three Central Authorities. To this extent only do they consider it practicable to constitute one Central Department for the United Kingdom. See paras. 27, 34

(viii.) The Committee are of opinion that benefit would be derived from the establishment of a National Fishery Museum, which had best be placed at a great fishing centre, such, for example, as Grimsby. In this museum might be exhibited such of the specimens of the Buckland collection as are worth preserving, and perhaps it may be found possible to apply Mr. Buckland's monetary bequest for the purposes of such a museum, which might very appropriately be united with the proposed laboratory for the east coast. See para. 35.

VII. CONCLUDING OBSERVATIONS.

38. In order to carry out the Committee's recommendations it will be necessary for the State to provide funds :— Objects for which State aid will be necessary.

(*a*) for the collection of statistics from trawlers and the examination of material at the ports ;

(*b*) for the provision of the necessary assistants at the Marine laboratories ;

(*c*) for the provision and maintenance of the three steamers recommended ; and

(*d*) for putting the staff in Scotland and Ireland on a permanent basis.

Effect of carrying out recommendations.

39. The Committee believe that by carrying out these recommendations the State would recognise, co-relate, and control the work of the existing independent organisations in the United Kingdom, and would build up a scheme of Fishery Research of a thoroughly practical character, centring, as regards England, in the Board of Trade, and, at the same time, in intimate contact with the fishing trade, the district committees, and the scientific laboratories round the coast.

Death of Mr. S. E. Spring-Rice, C.B.

40. The Committee feel that they cannot close this Report without placing on record the sense of the loss they have sustained in the untimely death of their valued colleague, Mr. S. E. Spring-Rice, C.B. At all the meetings for taking evidence he was present and took an active part. His powerful intellect and great official experience were of the utmost value to the Committee, and even during his last illness he proposed to send in a memorandum on the subjects under consideration, which, unfortunately, he was unable to prepare.

41. The Committee, in conclusion, desire to express their sense of the ability and industry displayed by their Secretary, Mr. R. E. Martyr, of the Board of Trade.

We have the honour to be,

Sir,

Your obedient Servants,

(signed) COLIN SCOTT MONCRIEFF
WALTER E. ARCHER.
D. CRAWFORD.
WM. SPOTSWOOD GREEN.
W. A. HERDMAN.
T. H. W. PELHAM.
J. ARTHUR THOMSON.

R. E. Martyr, Secretary,
24 September 1902.

MEMORANDA REFERRED TO IN REPORT.

MEMORANDUM RESPECTING THE COLLECTION OF FISHERY STATISTICS IN ENGLAND AND WALES.

(Referred to in paragraph 2 of Report.)

System in operation, 1886—1901.

The Board of Trade began the collection in a systematic form of statistics of fish landed on the coasts of England and Wales in 1885.

The annual Vote for the purpose was at first £500, but it was subsequently increased to £700.

In arranging for the regular collection of statistics, advantage was largely taken of the coastguard officers stationed round the coast, but in some places when such assistance was not readily available, and particularly at the more important centres, special collectors were appointed.

In 1901 there were 157 collectors engaged in collecting statistics in respect of about 161 places.

123	were coastguard officers.
2	were officers of the Board of Trade.
9	were Customs Officers.
23	were private individuals.
157	

The statistics collected related to the amount and value of all fish landed, and were rendered to the Board of Trade on monthly returns. These returns distinguished 13 kinds of wet fish, and three kinds of shell fish, the former being returned by weight, and the latter by numbers. The collector would record on a special form his daily entry of fish landed, and make from it an abstract of fish landed during the month, forwarding the result to the Board of Trade.

Some check was afforded to these statistics by the returns rendered by railway companies at the end of each year, showing the total weight of fish conveyed inland from stations on the coast, but in comparing the figures it was necessary to make allowance (1) for the quantity of fish landed, which was afterwards exported, or consumed locally, and the cleaning of fish after landing; and (2) the increase of weight due to boxes, ice, and packing, as well as the weight of shell fish.

Present System, 1902.

The railway companies in their returns took no account of value, and made no distinction between the kinds of fish carried.

The necessity and value of more accurate statistics had frequently been urged upon the Board of Trade, and on the 22nd August, 1900, an Inter-Departmental Committee was appointed to inquire into the system of collecting fishery statistics in England and Wales, and to report how it could be improved and extended.

As a result of the report of that Committee, His Majesty's Treasury has sanctioned an additional expenditure of £900 per annum for the purpose of providing additional staff at the two largest fishing ports—Grimsby and Hull—and of giving increased remuneration to collectors at other ports on the East Coast in order to obtain more accurate and extended returns.

The Inter-Departmental Committee, among other things, recommended that information should be obtained as to—

(a.) Number and class of vessels engaged in each method of fishing.
(b.) Description and amount of fishing gear used.
(c.) Number and duration of voyages.
(d.) Quantities of fish taken by nets, lines, and trawls respectively.

Steps are being taken to give effect as far as possible to these recommendations, which, when completed, it is anticipated will make it possible to determine, at any rate as regards boats of 15 tons and upwards engaged in trawl and line fishing, the total take and the power expended in the capture of the fish, and to distinguish the quantity of fish caught in the North Sea from that caught elsewhere.

At present the Board of Trade are confining the collection of more extensive statistics to certain large ports on the East coast of England, and to an endeavour to obtain returns of fish caught by steam fleets fishing in the North Sea and brought daily by steam carriers to London. This latter return shows in respect of each carrier the number of fish or boxes landed, with their total weight and value, the position of the fishing fleet served by the carrier, and the number of vessels boarding fish.

At the larger fishing ports on the East coast above referred to, the collectors now record in greater detail particulars of fish landed daily, distinguishing between the following kinds, viz.—

I.—Wet Fish.

Brill, soles, turbot, cod (large, medium, small), conger eels, dabs, gurnards, haddocks (large, medium, small), hake, halibut, lemon soles, ling, plaice (large, medium, small), skates and rays, whiting, herrings, mackerel, pilchards, sprats, all other except shell fish.

II.—Shell Fish.

Crabs, lobsters, oysters (native, including deep sea), oysters (foreign, previously laid down), other shell fish.

This is done on a new form (D), which, besides showing the quantities of fish landed, gives particulars of the name, length, and tonnage of each vessel, her method of fishing, the number of days absent on the voyage. It also affords particulars of the total number of fishing vessels (1st class) landing fish each day:—

(1) From grounds in North Sea south of lat. 61;
(2) From grounds off Iceland, Faröe, etc., and outside North Sea.

A monthly abstract of this information is sent to the Board of Trade in a form designed to show the catching power expended, *e.g.*, number of vessels—distinguished steam from sailing vessels—using otter trawls or beam trawls, average number of hooks used per steam or sailing liner, or average length of fleet of nets used by steam or sailing drifters, together with the total number of days expended on each description of fishing.

The object of obtaining returns as to the amount of fishing power is to enable some common unit to be established to which the take can be referred.

It will be observed that these forms are designed so as to afford the additional information suggested by the Committee on Fishery Statistics.

During the present year the system of collecting fishery statistics in England and Wales may be said to be in a state of transition.

At 11 ports on the East coast the statistics are collected in greater detail and with additional information, while, at all other stations round the coasts the old method of collection, as set forth in the first part of this memorandum, is still in force.

MEMORANDUM DRAWN UP BY THE EXPERT MEMBERS OF THE ICHTHYOLOGICAL RESEARCH COMMITTEE IN COMPLIANCE WITH A REQUEST MADE BY THE COMMITTEE AT THEIR MEETING ON MAY 29TH, 1902.

(Referred to in paragraphs 14, 15, and 23 of Report.)

(The paragraphs are numbered for convenience of reference and discussion. The numbers refer to answers given in evidence, but it must be noted that they are *illustrative, not exhaustive*. They are not to be taken as adequately indexing the basis of our criticisms and conclusions.)

1. The reference to the Committee may evidently be divided into two parts:—

(*a*.) "To inquire and report as to the best means by which the State or local authorities can assist scientific research as applied to problems affecting the fisheries of Great Britain and Ireland;

(*b*.) "and, in particular, whether the object in view would be best attained by the creation of one central body or department acting for England and Scotland and Ireland, or by means of separate departments or agencies in each of the three countries."

2. Plan of this Memorandum.—In this memorandum we have restricted attention to (*a*), and, acting on the Committee's instructions, we have more particularly discussed the Christiania scheme in its relation to fishery problems.

We have dealt with the matter under the following heads:—

Pars. 3-7.—I. The most pressing problems to be solved.

Pars. 8-13.—II. The methods requisite for the solution of these problems.

Pars. 14-26.—III. An examination of the methods proposed by the Christiania scheme, *considered in their relation to the fishery problems before us.*

Pars. 27-32.—IV. Suggestions of some practicable methods which may possibly be included in a modification of the Christiania scheme.

I. The most Pressing Problems to be Solved.

Problems. 3. What are the problems in question? There are many, but the fundamental practical problem at present is to establish the fact of an increased or a decreased yield of the fisheries within the readily available area of supply, and the most pressing part of this problem relates to our more sedentary and local fish—such as the flat-fish (plaice, sole, etc.).

The fact that the fundamental practical problem is to determine whether there is serious progressive depletion of readily available fishing areas is expressed very clearly, for example, in the evidence of Dr. Fulton: —"The primary thing is to ascertain the variation in the quantity of fish on the fishing grounds in different years; that is fundamental in connection with any regulations," and so on. The Swedish Hydrographical Commission also submitted to the second International Conference the following proposition, viz.:—

Q. 81. "The most important practical tasks of the International co-operation are doubtless the determination of whether the North Sea is being excessively exploited by trawling, or whether such exploitation is to be feared in the near future?"

4. If a decrease of a serious and progressive nature is established, we have to consider whether such decrease is due to natural causes or to man's operations.

5. If to the latter, we need to know *how, when* and *where*, in which localities, and at what seasons do particular kinds of fishing cause the decrease?

6. There is also the further problem, How can the fishing be best regulated so as to afford protection?

7. We have subsequently to consider:—

(*a*.) How can scientific research be applied to such problems, and

(*b*.) How can the State, etc., best assist such scientific research.

II. The Methods Requisite for the Solution of these Problems.

Statistics. 8. To work out the problem stated in paragraph 3, information must be obtained as to the amount of fish caught on particular banks by vessels sufficiently numerous to supply data representative of the total yield.

Samples. 9. To ascertain the physical conditions under which fish live, as well as the distribution of fish-food, fish-eggs, and fish during their different stages of growth, with a view of throwing light on the problems stated in paragraphs 4 and 5, samples must be taken at due intervals of time and space.

By "samples" we mean the raw material, whether collected by commercial fishing boats, special steamers, or other means, and also observations on the chemical and physical conditions.

Samples to be representative of area and period. 10. It is obvious, then, that any scheme of research, however elaborately planned, and however carefully carried out, will fail in its object if the samples are not sufficiently numerous in space and sufficiently frequent in time to be truly representative of the area and period which they are supposed to represent.

Numerous observations required. 11. To determine at what intervals of space and time samples must be taken in order that they may be representative of a given area and period, numerous observations must be made to show how far the conditions are uniform on the same or adjacent areas.

Method of obtaining data. 12. There seem to be three possible ways of obtaining the data referred to in the preceding paragraph:—

(*a*.) By the intensive study of some comparatively limited areas where it is possible to cover the ground so closely and so frequently that secure conclusions as to the population may be reached in a few years.

(*b*.) By utilising the material obtainable from a large number of commercial trawlers operating on a large area.

(*c*.) By means of a large fleet of special steamers working continuously with scientific methods over a large area for a term of years.

Objections to individual methods. Combination desirable. 13. Each of the three methods has its limitations or drawbacks, and some combination of them appears to us to be the most desirable plan of action.

The against (*a*) it may be argued, for instance, that conclusions based on the study of a small area may not hold good in regard to a large area.

Against (*b*) it has been argued that different skippers, etc., differ widely in their standard of accuracy in filling up returns, that it requires some expert knowledge to detect inaccurate returns, that increase in the number of foreign trawlers may in the future affect the value of returns from British trawlers unless returns can be got from the former as well as from the latter, and so on.

Against (*c*) it can only be said that the possibilty of securing the services of a large fleet of steamers is at present remote.

III. Examination of the Methods Proposed by the Christiania Scheme, Considered in their Relation to the Fishery Problems before us.

International programme.

14. According to the programme of International Exploration of the North Sea it is proposed :—

(1.) To determine the fact of increase or decrease.

(2.) To investigate the chemical and physical conditions of the sea.

(3.) To map out the bottom according to its physical character.

(4, 5, 6.) To determine the distribution of plankton of invertebrates and of fish populations, and to inquire into various other subjects of interest.

Aims of Christiania scheme.

15. As far as *aims* are concerned, the Christiania International scheme recognises the various factors to be considered in attempting to solve the fishery problems of the North Sea. It also includes investigations which may be of great importance to science as such. The methods proposed for carrying out this scheme are, however, open to criticism. If there were no pressing practical problems, if there were no limits to the financial support of the scheme, and if it were understood that the money voted for the investigations was voted as an endowment of scientific research in the belief that such research would eventually produce results of practical importance, then criticism of the methods to be followed would only be of secondary importance. But what we have to deal with in this programme is a definite proposal to accomplish certain aims by means of certain methods. It is in the hope that there may be some modification of these methods that we wish to indicate some of their limitations.

British proposals.

'16. It is proposed that the British portion of the investigation under the International scheme should be carried out by means by two steamers, working during three years at a cost of about £42,000.

Two steamers not sufficient.

17. If the International scheme is to attain to the results promised, it will require, as recognised in the statement of aims, to establish the increase or decrease of yield of certain areas of the North Sea.

To attempt this by means of two steamers from Britain (and five from other countries) suggests an inadequate appreciation of the magnitude of the undertaking. Furthermore, it seems to involve what appears to us an illegitimate assumption, that the take of a single vessel will lead to definite conclusions as to the number of the fish on the grounds at different times and localities irrespective of any fluctuations in the number of other vessels which may be at work on the area.

Disturbing factors.

The objection we have urged applies equally whether the area investigated is closed to commercial trawlers or not. For since fish may migrate from one fishing ground to another, as was shown in the case of the Firth of Forth, their abundance is affected not only by the fishing in the closed area, but also by that in adjacent areas.

Uniformity of conditions.

Q. 1512-4.

18. Considering the size of the area to be covered, and the ambitious nature of the programme suggested, it is evident that the samples must be far apart both in space and time. But the value of samples far apart both in space and time requires to be tested, and it seems plain that they will yield trustworthy results only on the assumption that physical and biological conditions remain uniform over large areas for considerable periods. The evidence we have received does not establish that assumption.

With reference to the evidence, we may consider the question of uniformity under the heads—Physical Conditions, Plankton, Nature of Bottom, Distribution of Invertebrates, and Distribution of the Fish Populations.

Physical or Hydrographical conditions.

Q. 1692.

Q. 1693.

19. In regard to the *physical conditions*, or *hydrography* we have had evidence from two experts—Dr. H. R. Mill and Captain Tizard, R.N., that both the surface and the deeper layers of water in a shallow area like the North Sea change in character very much both as regards one place compared with another, and one place with itself at different times. See also Captain Tizard, Q. 2125 onwards.

That we have to deal with uncertainties is plain if we compare Captain Tizard's evidence, *e.g.*, Q. 2162, with some statements in his subsequent memorandum.

And, again, while Dr. Mill suggested three weeks as the length of time required for a transverse test voyage, Captain Tizard suggested one week.

Conclusions.

20. The evidence seems to point to the following conclusions :—

(*a.*) That a quarterly examination of a given area is not sufficiently frequent. — Quarterly trips not sufficient.

(*b*) That stations at which samples and observations are taken must not be far separated from one another. Thus, for example, Captain Tizard suggests that they should not be further than 10 miles apart, and that they should sometimes be at intervals of three miles (Tizard's memorandum and Q. 2141). — Stations near each other.

(*c.*) That the observations along the different lines or sub-areas should be as nearly as possible simultaneous. — Simultaneous observations.

(*d.*) That in an area like the North Sea, which is shallow and fed by a number of large rivers, the physical conditions are subject to frequent and sudden changes (Q. 2126-2131). — Change of physical conditions.

(*e.*) That in this area, therefore, it is specially difficult to collect information sufficiently definite to warrant general conclusions regarding the distribution of fish. — Difficult to collect definite data.

(*f.*) That the abundance of flat fish such as plaice, does not seem to be subject to the same sudden fluctuations from year to year as that of round fish, such as haddock. This was shown to be the case in the Firth of Forth. See Chart 1, and Q. 1472. — Flat fish not subject to same fluctuations as round fish.

Plankton.

21. *As to plankton*, it is known that the amount and nature vary very considerably with locality, date, and even time of day. This is especially the case in shallow seas near land.

And while some witnesses expressed the opinion that the distribution was more uniform further out to sea, no conclusive evidence in support of this was brought before us.

On the other hand, the irregularity and discontinuous distribution of the plankton on the surface is a matter of common observation among naturalists who have done much work at sea.

In any case, looking at the great size of the area to be investigated in relation to the available means for carrying out such investigations, we feel bound to conclude that this question would have to be made the subject of a prolonged series of observations by a large fleet of special steamers before definite statistical conclusions as to the quantitative results could be drawn. Q. 2330.

Bottom.

22. In order to ascertain *the nature of the bottom* satisfactorily, dredging is absolutely essential.

It must be carefully noted that for biological purposes it is not enough to know the nature of the superficial layer, which might be gauged without dredging. It is also necessary to know the deeper layers in which the molluscs, etc., on which some fishes feed, are wont to burrow.

We must admit the possibility that the nature of the bottom may be uniform for considerable areas out in the open, but this point is uncertain, and requires to be investigated. Conclusions based on the study of the bottom deposits in great depths may not apply to a shallow basin like the North Sea, and in so far as the superficial bottom layer is an indication of the biological conditions of the bottom, evidence shows that in some areas there may be sudden changes within comparatively short distances. Q. 1930-2.

It has been shown that the nature of the bottom close to land is often very varied within short distances. It seems certain that the distribution of flat fish depends in great part on the nature of the deposits and on the nature of the food living on and in the bottom. Q. 2196-2201 &c.

Admitted that from a fisherman's point of view the nature of the superficial layer of the bottom is fairly well known, we point out again that this knowledge is insufficient biologically. It will require prolonged investigations to determine what number of samples are necessary in order to chart the bottom deposits of any given area. Q. 2201.

Distribution of Invertebrates

23. *The distribution of the invertebrates* frequenting or living in the bottom, which affects the distribution of fish, is to a large extent determined by the nature of the bottom. (See, for instance, the work of Mr. Allan.)

Stations not sufficiently close

But the programme of the International scheme does not seem to us to provide for a sufficiently frequent examination of the bottom at a series of stations sufficiently close together.

If taken along the hydrographic lines alone, the investigations will be inadequate.

If, on the other hand, the whole of the area assigned to Britain is to be adequately explored, a much larger number of vessels or a much longer period of work will be necessary.

Evidence as to samples being representative of neighbouring areas.

24. The experimental trawlings ("fishery experiments") of the Christiania programme for ascertaining *the distribution of fish populations* are presumably to be carried out by the special steamers.

If so, it must be on the assumption that "samples" taken at one place are also representative of neighbouring places.

But the evidence placed before us does not warrant such an assumption.

The evidence which is available in regard to the Firth of Forth points in the opposite direction.

And although it may be argued that observations taken in an inland area are not representative of the conditions in the more open sea, yet it must be borne in mind that the proposed investigations must apply to both.

Conclusions as to results to be expected.

25. To what conclusions does our expert evidence under the above heads lead us, as regards the results to be expected from the prosecution of the Christiania scheme in its present form?

(*a.*) The proposals show in outline the kind of scientific knowledge of the sea and its inhabitants, which it would be exceedingly interesting and desirable to obtain as contributions to hydrography and biology. As naturalists we are cordially sympathetic as regards the scientific value of the proposed investigations. It can hardly be doubted that the *qualitative* results would be valuable scientifically. It is chiefly in regard to the *quantitative* results that we have grave apprehensions.

(*b.*) If a sufficiently large number of steamers were continuously at work, and if the observing stations and periods were sufficiently frequent, results might be looked for which would give important contributions to the science of oceanography, some of which might also be found to have a practical bearing upon the movements of certain migratory fish, like the herring. But such definite results cannot reasonably be expected from the work of a few special steamers in three or five years.

(*c.*) It is doubtful, also, whether any such results, if attained, would have much practical bearing on our knowledge of the distribution of such bottom fish as the plaice.

(*d.*) While some of the practical questions at issue may be usefully investigated by some modification of the proposed scheme, we feel bound to express our grave apprehension of the danger of using inadequately substantiated quantitative conclusions as a basis for action or regulation of fisheries. For if "samples" misrepresent the actual conditions or inadequately suggest the causes of those conditions, they may prevent the possibly quite legitimate grievances of the fishermen being redressed, and they may be detrimental to the supply of fish generally.

(*e.*) Therefore we feel bound to say that results obtained from averages based on a series of observations distributed over a wide area, taken at relatively distant intervals of time, and involving the investigation of many different factors, would be just as likely to give erroneous as true answers to such definite fishery questions as the decrease or increase of flat fish on certain areas, and the presence of immature and under-sized fish in large numbers on certain banks, and the other questions included in our statement of problems.

Modification of scheme.

26. In our opinion results of practical value to the fisheries would be obtained if the aims of the Christiania scheme were modified, and if the method of carrying them out were amplified in the manner referred to in the subsequent paragraphs.

IV. Suggestions of some Practicable Methods which may be Included in Modifications of the Christiania Scheme.

(*a.*) Modifications of the Christiania scheme.

Quarterly trips to be abandoned.

27. In view (1) of the impracticability of carrying out reliable investigations as to the effect of natural causes on the abundance of the local sedentary fish at a reasonable cost, and (2) of the grave danger to be apprehended from partial results to which we have alluded, we recommend that the quarterly voyages proposed in the Christiania scheme should be abandoned.

Experimental regulation of fishing operations.

28. If this were done the special steamers would be set free for the more useful work specified under the next heading, and the effect of man's operations on the fisheries might be tested by regulating such operations experimentally.

(*b.*) Auxiliary methods of investigations.

Statistics.

29. In the first place, provision should be made at the principal fishing ports for the collection of statistics of the number of fish landed, and the place of capture, from a sufficient number of vessels to solve the problems given in paragraph 3. This might be done by the staff proposed by the Statistical Committee, with the assistance referred to in the next paragraph.

Examination of fish landed.

30. In the second place, suitable arrangements should be made at the port of landing for the examination of the fish brought ashore by the commercial fishing vessels, as it is only by this means that a sufficient quantity of raw material can be obtained at a reasonable cost to enable the main features with regard to the size, description, condition and food of fish to be determined. It must not be supposed, however, that this could be done on a sufficiently large scale and with sufficient accuracy to ensure reliable results without a considerable amount of trouble and expense, as provision would have to be made for the payment of masters of fishing vessels for filling up returns, and of a staff of trained assistants to deal with these returns, and with the material after it was landed.

Solution of special problems in particular areas.

31. If the main features with regard to the fish populations were thus obtained, the special steamers which it is proposed to provide might be most usefully employed in working out special problems on particular areas. By the combination of these two methods tolerably certain results might be obtained with regard to such questions as the localisation of fish nurseries, the size of fish frequenting such areas, the places where fish spawn, and problems of a like nature. The work done by special steamers could not, however, be relied upon to give information with regard to the fluctuations in the number of fish for the reasons given in paragraph 25. For this, which is the basis of the whole scheme, we must rely on the thorough carrying out of the recommendations contained in paragraph 29.

Cost.

32. We have not considered it necessary at this stage to give any estimate of the additional cost involved in carrying out these auxiliary methods of investigation, but we should be prepared to do so if the Committee desired it.

(Signed) W. A. Herdman,
Walter E. Archer,
Wm. Spotswood Green,
J. Arthur Thomson.

July 4, 1902.

LIST OF WITNESSES.

MINUTES OF EVIDENCE

TAKEN BEFORE THE

COMMITTEE

ON

ICHTHYOLOGICAL RESEARCH.

FIRST DAY.

Tuesday, 22nd October, 1901.

AT THE BOARD OF TRADE, 8, RICHMOND TERRACE, WHITEHALL, S.W.

PRESENT:

The Right Hon. Sir HERBERT MAXWELL, Bart., M.P. (*Chairman*).

WALTER E. ARCHER, Esq.
DONALD CRAWFORD, Esq.
The Rev. WILLIAM SPOTSWOOD GREEN.
Professor WILLIAM ABBOTT HERDMAN, F.R.S.
The Hon. THOMAS H. W. PELHAM.
STEPHEN E. SPRING-RICE, Esq., C.B.
Professor J. ARTHUR THOMSON.

R. E. MARTYR, Esq., *Secretary.*

Dr. T. WEMYSS FULTON, called; and Examined.

1. (*Chairman.*) You are Superintendent of Scientific Investigations of the Fishery Board for Scotland?—Yes.

2. You have been a considerable time at that work?—About fourteen years.

3. What do you consider the main object of your duties—what object do you mainly keep in view?—In carrying out the scientific investigations the main object is to acquire as much information as possible about the life history of the fishes, and the influence on the fish supply of the methods of fishing, so that the knowledge acquired may be of use in guiding regulations and legislation.

4. Have you acquired such knowledge during the fourteen years as has had any influence upon legislation and regulations?—We have acquired information upon the spawning of fishes and upon immature fish; questions of the kind that have been used as a basis for legislative proposals—for instance, the Immature Fish Bill—the Undersized Fish Bill.

5. Did you say the Undersized Fish Bill?—Yes, which was introduced into Parliament last year.

6. The mere fact of the destruction of undersized fish did not require much scientific investigation to show that it was injurious?—Well, before we began the investigations it was not known what was an immature fish; there was no definition of what an immature fish was; it was supposed to be a small fish irrespective of the condition of maturity, and it was really an investigation carried on by the Fishery Board that cleared up the whole question with regard to immature fish.

7. Do you use "immature" in a technical sense?—Yes—in a biological sense—an immature fish being a fish that has not spawned.

8. Then you collect statistics?—Yes.

9. What is the scope of these statistics?—The scope of these statistics ought to be to gain information to show whether there is a falling off or not in the abundance of fish on the fishing grounds, but I think that the statistics as at present collected do not give that information.

10. Why not?—Because they do not show the means of capture. They do not show the number of vessels that are engaged in catching the fish, and they do not show the places where the fish are taken.

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11. They just give the gross results?—The gross results, and you cannot well use information of that kind in connection with the regulations or legislation.

12. But I suppose regulations have been founded on these statistics?—Yes, they have.

13. The restriction of trawling, for instance?—Just so.

14. But do you think that those regulations are founded on imperfect information?—I would not say that they have been founded on imperfect information; but, perhaps, as I think, that they are a little illogical. First of all the statistics ought to give information obtained as to the condition of the fisheries, and then the legislation should have followed.

15. Do I understand that the regulations in your opinion have been founded on *à priori* grounds?—Just so.

16. Such as the injurious effects of steam trawling?—Yes.

17. Well, then, as to biological observation: to what extent has that been carried on in Scotland under the control of the Fishery Board?—To give an account of the whole work that has been carried on—the scientific work in Scotland—would take some time. I should be happy to prepare a memorandum for the Committee on that subject if desired.

18. The inadequacy of equipment of biological research has been reported on already, has it not, in the Fishery Board Report?—Yes, and by the Parliamentary Committee of 1893, and also by the Committee of last year.

19. You have something to say as regards the "Garland"?—Yes, it is only a vessel of 84 feet in length and 36 tons register, and last year out of about 303 ordinary working days she was engaged in scientific work on 112

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days, and lay in port for 166 days, the other 25 days being spent in steaming from one place to another; she was laid up for repairs to boilers, engines, and other parts on seven occasions which occupied 72 working days, the detention on the annual overhaul extended from 12th July to 6th September, and the cost was close upon £300. Now with a vessel like that really very little work can be done, that is to say, work of any value.

20. Have you formed any estimate as to what is required?—We require a steamer such as an ordinary trawler, a seaworthy steamer that can go out to the fishing grounds.

21. What crew should she require?—I think simply the same crew as the "Garland," perhaps an additional fireman.

22. What would be the additional expense of such a steamer?—The additional annual cost of maintenance, I think, would be very little indeed. I think perhaps £200 would make the difference.

23. Representing probably the coals that she would burn when at sea in the time now spent in port?—Yes

24. And the prime cost?—The prime cost would be about £9,000—£8,000 or £9,000.

25. You have not mentioned the approximate tonnage of this steamer?—It would be simply a little larger than an ordinary steam trawler, built on the same lines as a steam trawler. I could not give the tonnage exactly at present.

26. You have given the length of the "Garland" as 84 feet?—Well, it would be about 115 feet perhaps.

27. Have you any more observations to make on this proposed steamer or her work?—Well, if we had a steamer of that kind we would be able to carry on investigations out in the open sea, which we cannot at present do, on the fishing grounds where the trawlers work.

28. You employ directly or indirectly the co-operation of trawlers at present, do you not?—Yes, for a year past I have personally been going out on the trawlers once a month and working in the Moray Firth and Aberdeen Bay, and that is simply because we could not get the information from our ordinary boat, the "Garland." But the work on board the trawler, while of course you cannot get very good work done, is extremely disagreeable.

29. You do not rely upon observations of trawling captains unless you are personally present?—I should not rely upon the place of fishing in some cases.

30. Could you employ them as collectors?—I do not think it is necessary to employ them as collectors. Do you mean collectors of the fish?

31. Fish or fish food?—No. I do not think we could employ them as collectors of fish food.

32. Have you come to any opinion on the proposal for international co-operation in deep sea work?—I think it would be a very good thing to prevent overlapping of work, and it would tend to better conclusions. But I do not think the Christiania Programme is perfect by any means; I think it is defective, especially in the point I have mentioned that no provision is made by which you could ascertain the quantity of fish caught on the different grounds, and the number of vessels in the different years. At the end of the work I do not think you would be any further advanced from the practical point of view than you are now, because there is nothing that I can see that would give that information.

33. How do you obtain that information—by tabular forms supplied to fishermen?—Yes, and I get the information at present at a very small cost in Aberdeen. This is a form showing the quantity of fish and the different kinds of fish caught, the time of fishing, and the place where the fishing takes place. (*Handing in the same.*)*

34. What do the figures refer to; do they refer to cwts.?—Yes.

35. How was this obtained?—This was obtained by the clerk who obtained statistics of the fish landed. He obtained this by a personal interview with the trawling skippers.

36. The quantity of fish landed?—Yes, and the other particulars.

37. And you think by co-operation with foreign Governments that detailed information might be extended all over the North Sea?—Yes, this information must be put on a chart. I could have it ready in two months, showing precisely the position where the different hauls were taken, and if a system like this was adopted by the different countries, in the course of a very few years we would have very important information.

38. Well, now, to pass to another subject, the question of centralisation of fishery authorities. Do you think it would be an advantage to the fishing interest if the three kingdoms were combined under one administration?—The question is one of considerable difficulty. But it seems to me from the present condition of the administration that three departments, one associated with each of the fishery departments, would be most economical. There must in any case be a close association of the Scientific Department with the Fishery Department, even in this question of statistics, and it seems to me, seeing that there are three fishery departments, the simplest way is to have a scientific department connected with each.

39. You do not consider that the present system is any hindrance to the advance of knowledge on the subject?—In one respect I think it is. I think that there might be conferences between the different departments as to the preparation of a joint scheme of work.

40. That is compatible with the present system?—Yes.

41. There is no machinery for that at present?—I think not.

42. Well, then, the suggestion is that there must be overlapping in the work of the different departments at present?—There is, I think, to some extent. Of course scientific investigations must be carried on in each country whether by one department or by three departments. But certain investigations, I think, for instance, the development of fish, could well be done by one department—the more purely scientific part.

43. Political divisions do not also coincide with natural and physical divisions; for example, the east coast of Scotland stops politically at the mouth of the Tweed, but the same series of observations which covered the Scottish coast would naturally be extended to the Northumberland coast?—Just so.

44. Does there exist any overlapping of work such as that?—I do not think there is any work carried on on the east coast of England to any extent.

45. Does your work go on south of the Forth?—Not at present.

46. Then on the other side of Scotland the Irish fishery observations and the Scottish Fishery Board determine in the Solway?—Yes, in the Clyde practically.

47. It appears from your reply that the Scottish Fishery Board does not cover the whole of the ground at present?—The whole of the ground in Scotland?

48 Yes?—No, it does not cover the whole of the ground in Scotland.

49. Is that temporary or permanent?—Well, it is not every part in which you want to carry on scientific investigations.

50. Would you explain why?—I do not know, for instance, that scientific investigations need be carried on in the Solway unless some special question arose.

51. Pardon me, but you have introduced the adjective "scientific"—I used the general substantive, work—the work of your department. You say it does not extend further south than the Forth at present or of the Clyde?—The work of the Fishery Board does extend further—it extends to Berwick.

52. But you said no investigations had been made in the North Sea, off the east coast of Berwickshire?—No, there are not.

53. Very well, but I want to know why is that so?—Do you mean off Berwickshire specially?

54. I mean precisely what you said. I asked you whether there was any work going on north of the Tweed, and you said none. What I want to know is why not?—Investigations have been going on in the Firth of Forth and the Moray Firth—scientific investigations.

* *See* Appendix II.

55. Again you introduce the word "scientific"?—Do you mean ordinary administrative work, such as the collecting of statistics?

56. No. I have in mind the tabular form which was just handed in, giving the returns of fish caught in certain areas. I do not suppose you would call that scientific?—Well, it is rather difficult to draw the line between what is scientific and practical. In this case, for instance, you require a certain amount of knowledge to distinguish the different flat fishes, and I find that the fishery officers and the fishery correspondents in some cases have not got that knowledge. And then it is a question also whether the working up of information of this kind would not be scientific properly; for instance, the preparation of the charts showing the places where the fish were taken and dealing with all this information—I do not know whether that ought to be called scientific or not.

57. Let the term scientific stand. I was connecting it with biological investigation. But, at all events, you are not doing any scientific work now south of the Firth of Clyde?—No.

58. What I wanted to know was why that area should be neglected. If scientific investigation is of use in the Moray Firth, why not in the Firth of Clyde and off the coast of Berwick?—Well, just so; but, of course, the work cannot be carried on all round the coast.

59. For want of means?—For want of means, and I do not think it is necessary. Certain investigations are carried on in the Firth of Forth and Moray Firth, and of course a vessel cannot be all round the coast working at the same time.

60. No, but a return like that can be made round the whole of the coast?—This return certainly. This return is not a scientific return in the sense of being got by scientific vessels. It is got simply from the fishing boats, trawlers, when they land the fish.

61. What puzzles me is that you seem to confine your enquiries to certain parts of the coast, whereas if an international scheme is in contemplation it is surely obvious the more extended it is, and the more completely you cover British waters the better?—Yes, but, of course, in that case if it was meant to carry on scientific investigations in every part of the area, proposed by the Christiania programme, you would require quite a fleet of steamers. I am quite certain of that from the work of the "Garland." This work must be carried on in the same localities or nearly the same localities as are given in these returns, and this represents an area of about 800 miles in length. This represents the area assigned to Britain, and I am quite certain from my experience in the "Garland" in Scotland that to carry on investigations throughout the whole area would require a large fleet of steamers, and, moreover, it is confined to the east coast.

62. You have quite departed from my question. I referred to a table like that which you have already handed in, and which you characterise as purely scientific. What I want to know is if it is important to get that information from the Moray Firth and Firth of Forth, why not from the Berwickshire coast and the Firth of Clyde, and so on?—This is not the information got from the Firth of Forth and the Moray Firth, as is shown by the places where the fish are caught. This is from Aberdeen, and the trawler landing the fish there gives this information, which refers really to the whole of the North Sea.

63. But you have no information with regard to the other sea—to the Solway Firth?—None whatever.

64. And you say it would be useless to have such information?—In connection with the Solway Firth there are no very important fisheries carried on there except in connection with the salmon fishery.

65. (*Mr. Crawford.*) You spoke about the statistics, and said that legislation had rather preceded instead of followed the statistics; is that so?—Yes.

66. How long has the Fishery Board had the power to obtain such assistance?—Since 1886.

67. Under an Act of Parliament?—Yes.

68. And those are collected by the fishery officers?—Yes, and by the correspondents.

69. And they are collected, I understand, for the whole coast of Scotland?—Yes.

70. Without any exception?—Yes.

71. Then this return that you have obtained from Aberdeen, how long have you been obtaining that return?—Since the beginning of this year. I may say that it accidentally occurred that a similar return was got for a special purpose ten years ago, for three months, and I saw it would give an excellent opportunity of comparing the condition of the fishing grounds ten years ago and now, and I at once got this done, and I have carried it on during the present year. I may say that the cost is quite nominal; I pay 5s. a week and get the results of altogether 40 or 50 trawlers.

72. That is an experiment which you found useful, which has been initiated by yourself within the past year?—Yes.

73. And if it was desirable, probably there would be no particular difficulty in getting a similar return from your other fishing ports?—I cannot see how there can be difficulty. The statistics of the fish, the quantities of the fish, must be got, and the only thing additional is to find out the number of hauls, and the places where the boats have been fishing. In some cases I understand you cannot always trust the information, but the man who collects the statistics knows which men he can trust and which men he cannot trust.

74. Well, what is the difference between the information given by that Aberdeen return and the statistics that are sent to the Fishery Board from every station in Scotland?—Well, the great difference is this: First of all, there is a difference in the differentiation of the fish. This return is much more elaborate, much more extended, than the ordinary return published by the Fishery Board, but the main point is that by means of this information you can ascertain whether the quantity of fish on the fishing grounds is increasing, or stationary, or declining. You cannot do that from the present returns, because you have not got the number of boats fishing, or the time of fishing, and you have not got the place of fishing. Now the place of fishing is a very important matter, and I have here some statistics which show it, and this is not shown in the ordinary returns at all. During the past five or six years the area of fishing for trawlers has very greatly changed. It has shifted further north, and the result is not sufficiently known. For instance, in 1897 the quantity of plaice landed at Aberdeen was 25,000 cwts.; in 1900 it was 20,000 cwts., whereas witches have increased from 4,900 cwts. to 24,300 cwts., and megrims from 1,500 cwts. to 12,000 cwts. In other words, in the course of four years the bulk of flat fish, instead of being plaice, as hitherto, are now witches and megrims and that is chiefly owing to the fact that the area of fishing has changed and the trawlers are working further north. Information of that kind is not given.

75. You would get the quantity but not the place where they came from by the ordinary statistics?—You would not get the quantity of each boat. You would not get the number of boats. You would get the total quantity of fish landed at each port.

76. Of each kind?—Yes.

77. But you would get the number of boats?—You cannot use it. You get the number of boats registered at the port under a different return, but you cannot use it because some of them may not be fishing at Aberdeen, but elsewhere, as at Grimsby; others may be trawling only part of the year, and boats from other ports may land fish. For instance, foreign boats land their fish there, and are not included in the returns.

78. I did not intend to suggest—for from it—that yours is not very valuable; but I only wanted to know whether there was a difference between your return and the ordinary statistics?—The fundamental point is to ascertain the particulars of the individual catches. You cannot do so perhaps in the case of all vessels, but it ought to be done in the case of a sufficient number of vessels to give you a result upon which you can rely, and I think that money spent on this would be very well spent. I think it is primarily more important than purely scientific or biological investigation.

79. I just wanted to bring that out. The information, if it could be got from every part of the coast such as you are getting from Aberdeen, would be the kind of information to supply the statistics that you say are so necessary?—Just so.

80. With a view to legislation?—Yes.

81. Now, if that be so, what else is it that is required to be got by a scientific steamer; why do we require a scientific steamer?—For other reasons. From my experience in the "Garland" and trawlers, I have come to the conclusion stated, that you cannot obtain this

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statistical information by means of a scientific steamer, especially in any large area such as that represented there—you would require a fleet of steamers. You must get this information from a large number of fishing boats, and each trawling of these trawlers I consider to be a scientific experiment if you get the precise particulars in connection with them. If you get the place, the quantities of fish caught, and so forth, then it is a scientific experiment just the same almost as of a scientific steamer. But then a scientific steamer is required for other investigations. The primary thing is to ascertain the variation in the quantity of fish on the fishing grounds in different years; that is fundamental in connection with any regulations, because if it can be shown that the fish are remaining in proper numbers, then it is not necessary for a regulation or restriction. But once this information is got, and if it is found that the fish on certain fishing grounds are diminishing, then we ought to consider what sort of remedies to apply, and it is at that point that biological investigation appears to me to be very important. For instance, the localisation of the nurseries of fish, the places where fish spawn, and questions of that kind. It is then the moment for regulations and the scientific investigations are important. That is my view.

82. As to the "Garland," she has made investigation, has she not, on the west as well as on the east coast, in Loch Fyne, for example?—She is working on the west coast at present.

83. Do you think if you had a good scientific steamer sufficiently large and powerful that she would be able to do all the biological work that would be required on the Scottish coast?—I think so. You see the "Garland" is really very much in port.

84. What is your estimate of the amount of the cost of such a boat—from £8,000 to £9,000?—I have gone into this matter at Aberdeen, it was remitted to myself and the scientific member of the Board and the Chairman about a year ago to inquire into the question—and that is the result. A first-class trawler costs about £6,000; but certain alterations require to be made for scientific work.

85. What is the crew of the "Garland"?—Eight.

86. You said that would be sufficient. Now, compared with the fishing cruiser "Minna," the idea was that it was to be a kind of glorified trawler, and I think the crew of it is 21?—Yes, the crews of the cruisers are much larger, but the crew of an ordinary trawler numbers, I think, nine.

87. You think that, or about that, would be sufficient for the new "Garland"?—I think so. I think for two or three years the scientific steamer, if like an ordinary trawler, might be run for £1,200 a year, the cost of the "Garland," because £300 of this sum was spent on repairs last year. But I think £200 a year more, or about £1,400, would really meet the additional expense of coals.

88. When you say that the existing legislation about trawling was passed on *a priori* grounds, it was not passed without some inquiry, was it?—I was not connected with the Fishery Board then, but I rather think that the waters were first closed, and then investigations made.

89. But prior to the whole of the Moray Firth being closed there were Parliamentary Committees and Commissions?—There was an inquiry of that kind by a Committee who took evidence.

90. Was that not so?—I think so.

91. You think the first step was taken when the three-mile limit was imposed, and that that was done before the statutory statistics were to hand?—Yes.

92. (*Mr. Pelham.*) In your opinion, could the present system of statistics be improved without much cost, so as to obtain particulars as to the place of capture?—Yes.

93. And without much cost?—Yes.

94. Does that list that is provided by the collector at Aberdeen take in all the trawlers?—No; it takes in between 40 and 50 Aberdeen trawlers.

95. And does the collector continue that during the year?—Yes, during the year, and the extra cost of this is 5s. a week.

96. Now, supposing you had an effective vessel in place of the "Garland," you would still be desirous of utilising the ordinary trawlers?—Yes. You mean for this purpose?

97. Yes?—Yes.

98. And perhaps for any other work?—Occasionally perhaps. But I think it would not be necessary, if we had a competent scientific steamer, to use the trawler much—it might be rarely required.

99. Would your trawler have a biologist on board, or would the biological work be done at home?—You mean on the scientific steamer?

100. Yes?—Yes, there would be one on board.

101. And a chemist, too?—Not a chemist.

102. And any samples taken would be referred to a chemist on shore?—We do not do that.

103. Would not that be necessary for carrying out the programme of the Hydrographical Conference?—Yes.

104. Supposing you had one steamer at work all the year, or even more steamers under the Fishery Board, in your opinion would they be able to solve the questions which the Hydrographical Conference wished to solve?—I do not know very well which question you mean.

105. I meant as to the existence of fish in particular parts of the sea?—You mean the distribution of fish?

106. Yes?—They would be able to ascertain the distribution of fish, but the distribution—the presence or absence—of fish, is not sufficient. We must find out whether the fish are declining in abundance.

107. That is what I meant by the existence of fish and the distribution of fish—I meant the number?—No, they would not be able to find out that.

108. And you consider that could only be properly ascertained by means of a large fleet of trawlers engaged in trade?—Just so. My idea is that if you get precise particulars of the fishing fleet it is equivalent to having for this purpose a fleet of scientific steamers.

109. I suppose one or two steamers employed by the Central Authority would have to continue their work for many years before they would have sufficient data on which to form any conclusions?—Yes, they would.

110. Does it strike you that the fishing interests of England and Scotland in this matter are somewhat different?—No, I do not think they are very different in connection with the result do you mean?

111. I do not know whether Scotland would be thinking of inland waters and England more of the open sea or *vice-versâ*?—You mean in connection with the international investigation?

112. Yes?—I do not think there is much difference between the two countries.

113. Apart from the international arrangement would not the fishermen of England be more interested in the North Sea than Scotland?—In the North Sea, off the English coast.

114. I meant off the North Sea generally?—I think that they are both equally interested in the North Sea.

115. I suppose England has not so much inland waters as Scotland has?—No.

116. They have not got the Moray Firth?—No.

117. (*Mr. Archer.*) You were speaking of the advisability of collecting statistics from trawlers. You probably know that there are three fleets working in the North Sea which send fish direct to the London market by carrier. Do you think it very valuable to get statistics from them as to where the fish would be brought from every day with the carrier?—Yes, I think it would be.

118. That would be one source from which you could collect the statistics to which you are referring?—Yes.

119. Then with regard to the special scientific steamer: what extent of ground would she be able to work over in the course of the year?—That is a very difficult question, because it depends first of all upon the scope of the investigations—the nature of the investigations. If it was simply to make collections and to take temperature, for instance, she might cover a considerable area, but I am quite certain that one vessel would not be sufficient from the English Channel to the Faroe Isles.

120. May the biological researches recommended by the Christiania Conference be regarded as a develop-

ment or extension of what the Fishery Board have been doing, so far as their means would allow, for some time back?—Yes, I think so.

121. Have you any facts which you could put before us showing what measure of success we may hope to obtain from the investigation of the North Sea fisheries by the method adopted by the "Garland"?—Yes. What I expect the special boat, or two boats, would do, would be to ascertain where the fish spawn, where the nurseries of small fish are, and the questions of that kind. In fact, generally as given in the Christiania programme.

122. How near to one another do you think the observations would have to be made in order to get reliable data as to the distribution of fish on any particular area?—It is rather difficult to say that. If you mentioned an area I might be able to tell you.

123. Is it not on that, that the number of steamers required to carry out the work would depend?—Yes, it is.

124. For instance, take the Firth of Forth: you have made certain trawling observations in the Firth of Forth?—Yes.

125. What is the size of the Firth of Forth?—I think about 30 miles long by an average breadth of 8 or 10 miles.

126. Do you happen to know the area?—I cannot give the area.

127. How many stations are there on the Firth of Forth?—Nine stations.

128. Did you find a marked difference between the quantity, the description, and size of fish taken at different stations?—At some of the stations.

129. Supposing you had not had so many stations, would a smaller number have given reliable results of the conditions of the Firth of Forth?—Do you mean instead of nine stations, if we had perhaps four or five.

130. Supposing you had only selected three of the nine existing stations, what then?—Of course, the results would not have been so reliable, to that extent.

131. You have not got actual facts showing what was the result at each station?—Yes, and they are published, but I could not tell you the particulars of each station just now.

132. How many steamers would it require to investigate the area allotted to Great Britain by the Christiania Conference if the stations were placed as near together as those in the Firth of Forth?—It would require a very large number of steamers indeed.

133. Therefore you could not hope to do the work in such detail by means of a special boat?—No. But there is this difference. The work in the Firth of Forth was really to determine the fluctuation in the abundance of fish and not simply to carry on biological investigations. But in a scheme like this I have described the fluctuation of the abundance of fish from year to year would be otherwise determined, and the work done by the scientific steamer would then be more purely biological, and in that case relatively the steamer would accomplish in the North Sea what the "Garland" has done in the Firth of Forth.

134. You think that those statistics to which you are now referring, that is the statistics of the quantity of fish taken by a certain number of steam trawlers, would give you reliable data as to the fluctuation in the abundance of fish?—I think so.

135. Do you not think that would to a great extent depend upon the number of boats working at different times?—I do not quite understand.

136. For instance, unless the quantity of fish on a certain bank were unlimited if you had 50 steamers fishing they would not probably take the same quantity of fish as 25 boats?—No, on a limited area, certainly not.

137. But I suppose the North Sea is a limited area?—Yes, it is limited.

138. I think in your evidence before the Committee of the House of Commons in 1900, you said that the trawling fleet working from the North Sea ports at the present time is sufficient to trawl over the North Sea twice a year?—I do not recollect that; perhaps I did.

139. Therefore, if the area is limited, statistics of the take of only a certain number of boats would hardly give you reliable data as to the variation in the abundance of fish?—I should certainly say it would. If you have got information from a sufficient number of vessels it would show you the abundance of fish on the fishing grounds.

140. But surely for that you must have the conditions uniform from year to year as to the catching power?—Yes, that is what I aim at.

141. But you do not propose to obtain takes of all the fishing vessels, but only a certain number?—As many as possible.

142. But unless the number from which you obtain statistics increases at the same ratio as the increase in the catching power, it would hardly give you reliable data?—I do not quite follow you. If information of this kind, for instance, is got from half the Aberdeen trawlers, I should say that that would very fairly show the catch of the whole of the Aberdeen trawlers on these different grounds.

143. Possibly, but would it show the productiveness of the fishing grounds?—I think it would.

144. But supposing the vessels fishing from Grimsby and Hull over the same grounds increased, would the Aberdeen trawlers catch the same proportion as in former years when there were fewer vessels?—No, I think not. But in Grimsby and Hull I would expect the same information to be obtained.

145. From half the vessels?—As many as possible. If it were compulsory it would be much better—I mean by Act of Parliament, if you had power to compel that information.

146. You said in answer to Mr. Pelham that England and Scotland were equally interested in the North Sea fisheries. Is it not the case that the number of steam trawlers in England is very much in excess of that in Scotland?—Yes, it is.

147. The number in England is rather over 1,000, those in Scotland being under 200?—Yes; on the other hand the English steamers are now fishing in the northern waters.

148. (*Mr. Green.*) The only thing that struck me was this: as to the reliability of these statistics that you got from these trawler skippers. Is it not a fact that a trawler skipper finding a good piece of ground, does not care to have it published. He likes to keep it to himself?—Yes.

149. Does it occur sufficiently often that reticence in the steam trawler skipper invalidates the statistics?—These men only give the information on the official promise that it is for the time being kept secret.

150. And then you publish it?—Yes, afterwards. They have no objection to the information being published a year afterwards. What they object to is giving the information to other skippers, and then the other boats going and getting the fish. But they have no objection to do so after a year has elapsed. Some men are not so reliable as others. But if these returns were made compulsory by an Act of Parliament, and schedules were handed over to each trawler skipper than they would be compelled to fill it up under a penalty just as they supply ordinary statistics now. I am convinced that this is the chief thing which is wanted in dealing with the fisheries.

151. (*Mr. Spring-Rice.*) These statistics which you have been describing have been collected from trawlers?—Yes.

152. And you would like to add to the Aberdeen fleets others at Dundee and other places?—Yes.

153. And if you got a majority of them to give you returns which you thought fairly trustworthy, and still more if you could get similar information from England, you think you would have valuable material about the important fishery problems in the North Sea?—Yes; from year to year you would get the basis. For instance, if it was found that the quantity of plaice was diminishing very rapidly in the course of five years, that would point to some necessity for regulation or a convention perhaps. On the other hand, if it did not diminish it would point the other way.

154. And you would regard this part of the problem as the important one?—Yes.

155. And largely because it is the most important in a money sense, as the value of the fish landed by steam trawlers in Scotland must be a very large proportion of the whole of the fish landed?—It is more than half, other than herring.

156. Aberdeen alone lands other than herring one half, and by steam trawlers?—Yes.

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157. And the same state of things exists in England—the steam trawler fishing is the larger and the most important in value?—Yes.

158. And that is one of your reasons for concentrating your attention upon that?—Yes; but my chief reason is this, that the whole question of international action in the North Sea depends upon whether the supply of fish is diminishing, or stationary or increasing. No purely scientific investigation as in the Christiania programme can give you a reply to that. At the end of five years this programme I have described might answer the question, and then I think the statistics of this kind collected by the different countries from a large number of vessels, would convince other nations, if there was a diminution, of the necessity of making regulations.

159. Supposing it was agreed that the problem of the North Sea should be taken up internationally, you would recommend your method to be applied at all the ports from which steam trawlers are working by the different countries interested?—Yes, and there are not so many ports.

160. That in your judgment is the problem which it is important for England and Scotland to investigate before the other problem is taken up?—Or along with the other problem.

161. I gathered from you that this is the most important?—Yes, it is the most important.

162. And if you cannot do everything at once you would recommend that that should be taken up first?—Yes, but of course the purely biological work might go on simultaneously.

163. Certainly, but the biological work might be going on with reference to the same problem?—Yes, with reference to the regulations or the particular measures desirable at the end of the five years.

164 For instance, the question of the size of fish at maturity, that is a biological problem?—Yes.

165. There is no necessity to publish returns in this form in your Report, is there?—No.

166. They are not wanted for publication, but for working up in an office?—What I intend to do is to put all this information upon charts and to classify the areas for the different fish in the different years.

167. And having got it in that form there is no need to publish any of those particulars?—It may be necessary to publish some of them.

168. But with a view to the natural reticence of the skippers you could practically promise not to publish any of the particulars?—They do not insist upon that. After the lapse of a year it is not of value to others because they have discovered the new grounds themselves by that time.

169. But still the point of your investigation is that you want this information to work up, but not necessarily for publication?—Yes, that is so.

170. You have got besides the "Minna" the two other guard boats in the Fisheries Board?—I think we have the "Brenda," the "Vigilant," the Minna," and there is a small one, the "Norna."

171. Cannot you utilise them for any observations of a statistical or scientific character?—There is an objection on the part of the board to have the purely police work and the scientific work mixed up. Possibly some scientific work might be done—tow-netting and things of that sort.

172. (*Mr. Crawford.*) What is the tow-netting?—It is simply a muslin bag on a ring drawn through the water. The trawl is a very different thing on board a cruiser, and it requires a large steam winch.

173. (*Professor Herdman.*) You have been out personally yourself in a trawler, and not only had statistics collected for you?—Yes.

174. I rather gathered that your opinion was that by doing so you can get much more important results than with the scientific work on board the "Garland"?—Yes.

175. Might we gather that you still require a great deal of further information of that kind in the interests of the fisheries?—Yes.

176. Do you feel that you can get it from the international scheme as put forth in the Christiania programme?—I think that we might get a good deal of the biological information, but the fundamental point is wanted about the abundance of fish, and even, I might point out, some of the details require modification in accordance with the changes that have taken place. For instance, you find here under the biology of food fishes on page 11, at the bottom, "preparation of charts showing the distribution of plaice, sole, turbot, cod, haddock, and herring in the North and Arctic Seas." But the most important flat fishes, those landed in the greatest numbers in Scotland, are omitted, that is witches and megrims.

177. I rather gather you think that the Christiania programme has not much practical bearing on the Scottish fisheries?—Not immediate, perhaps.

178. I have heard it suggested that the chief practical motive for our participation in that international scheme should be that Great Britain would thereby secure an international treatment of the immature fish question. What treatment would you expect would be secured by this scheme?—There is one paragraph in it which refers, on page 15, paragraph 10, to the delimitation of the nurseries of immature fish. That seems to be the only thing.

179. I suppose you consider that there is a very great deal of destruction of immature fish on the east coast of the North Sea and on the banks off the German and Dutch coasts?—Yes.

180. Have those grounds been explored?—Not by the Scottish Fishery Board. I believe the Manx Biological Association have done work there.

181. Do you think it is impossible to say from what we know that the size limit proposed, for instance, in the Undersized Fish Bill would be effective in protecting the fish, or do we not know enough of the grounds—are they not sufficiently explored?—We do not know enough of them.

182. In your experience of trawling with trawlers, would you say that the imposition of a low size limit would deter trawlers from going to these grounds?—On the east side of the North Sea?

183. Yes?—I am not quite certain. What sort of size for plaice?

184. One that is evidently too low from a biological point of view—8 or 10 inches?—That would not deter them: a biological limit would probably not deter them from going there.

185. But as near as 10 inches?—I cannot speak about that in particular.

186. Now, is the work that you advocate, and that you think we chiefly require to do in the sea, of the nature of, merely for the sake of brevity, let us say, approximating to a census?—Of the fish?

187. Yes, and trying to get as accurate a knowledge as we can of the populations of different areas?—That is the fundamental question.

188. In order to get at the information of that kind how often do you consider that periodical observations require to be taken?—Do you mean by trawlers?

189. By anybody. Supposing you have a fully-equipped boat?—I should say as often as possible.

190. But is quarterly enough?—Quarterly might be enough. It depends upon the size of the area. With a proper trawler in the Firth of Forth, quarterly would probably be sufficient.

191. And once a month would be better?—Yes, better.

192. It would not be too often?—No, but quarterly with a large trawler carrying a full-size trawl, and making a thorough examination in the Firth of Forth, in that area it would be sufficient.

193. Both services would be required for the Firth of Forth alone?—I understood you to say how often trawling would be necessary. I mean in an area the size of the Firth of Forth, and with an ordinary trawler I should say once a quarter might be sufficient.

194. (*Chairman.*) For census purposes?—Yes, for census purposes.

195. I understood that this return was specially for census purposes?—Yes.

196. Your monthly observations would not suffice for that return?—You could only find out the census in a limited way by scientific steamers unless in a small area.

197. (*Professor Herdman.*) Do you think five years is long enough to extend such observations over?—No, I do not think five years is sufficient.

198. Supposing Great Britain were to participate in

this international scheme, what position would we be in at the end of five years?—For practical purposes it would be very much the same as now. Perhaps with the exception of that area you spoke about on the eastern side, the immature fish area, you might have more information about that, but I am quite convinced that at the end of five years sufficient information to say whether there is a decrease of the fish supply of the North Sea—on the fishing grounds there—could not be obtained.

199. Can you give us any more definite idea as to what area one steamer could work efficiently? You have told us that it could not work the whole east coast of Scotland?—The whole east coast of Scotland?

200. The whole east coast of the North Sea I ought to say—the area marked on your chart?—No, I do not think so.

201. What area could one steamer do?—According to this scheme, those steamers have to find out this fluctuation in the abundance of fish: they have to make the census. That alone involves a very great deal of work; but if that be put aside then you would require two.

202. For the east side?—I think so.

203. That would not allow anything to be done on the south or west coast, that would be the east coast of England alone?—Yes.

204. I rather gether that the "Garland" would not participate in the work—she is unfitted?—She is quite too small.

205. Do you think that the steamer would require to be of the same character as a deep-sea trawler in order to carry on such work?—Yes, a steamer that is not of the type of a deep-sea trawler is not suitable for the work at all.

206. Do you consider that it is still an experimental problem whether we can get sufficient data to enable us to have an accurate knowledge of the fish populations of the North Sea, call it a census for the sake of brevity; do you think that it is still experimental, or do you think that we can get it?—I think it is certain that we can get it.

207. And that it would not be advisable to do the work on a smaller area first?—Well, of course, the smaller the area the more certain the result.

208. But my question was rather: Do we feel sufficiently confident as to what we have got to do in order to come to a definite result—to justify us in embarking on that very large area in the North Sea?—Not certainly as it is at present. I do not think that this programme as drawn up would be satisfactory. I do not think it would be worth this country embarking at a cost of perhaps £30,000 in starting this unless there was some definite means agreed upon first of finding out the fluctuations in the abundance of fish—I do not think it would be worth starting it.

209. I have a few questions to put to you now as to the organisation of such work. Do you think that a scheme should be organised in Scotland independently of England?—I cannot speak very definitely about these questions, but I think that it might be.

210. (*Chairman.*) Is that consistent with what you said to me?—Do you mean this international scheme?

211. (*Professor Herdman.*) I meant the investigation of the sea, whether by an international scheme or otherwise. I was thinking simply of the work, not of the means of carrying it out?—I think it is immaterial from a scientific point of view whether it is combined or not. But it seems to me that having already separate departments and the scientific investigations, the biological investigations, being closely associated with what is done by those departments, they might as well be three separate departments.

212. Do you consider that the fisheries interests of England, Scotland, and Ireland are identical or diverse to some extent?—They are to some extent, because the fisheries are different—at least, to a large extent the fisheries are different on different parts of the coast, and the legislation, regulation, and the administration is different in different places.

213. (*Mr. Spring-Rice.*) Confining yourself to the business of steam trawlers would you see any difference between the steam trawlers from Aberdeen and Grimsby?—No, I do not think so.

214. (*Professor Herdman.*) You know the state of affairs in England where we have district committees?—Yes.

215. That, of course, is different from the arrangement in Scotland, where they have one Central Board?—Yes, and no committees.

216. Have you formed any opinion as to that, as to which plan is the better one?—No, I have not formed any opinion with regard to that.

217. Do you think it is essential with regard to the scientific work now, not merely the administrative work, that England should have one central authority, or do you think it would be possible to carry on such work by means of District Committees?—I think that the District Committees—which have certain powers of carrying on work now, I understand, and do it in some places—I certainly think that their work ought to be encouraged. But it might be at the same time brought into relationship with the central department.

218. (*Mr. Crawford.*) Is it not the case that District Committees may be created in Scotland under the existing Acts?—Yes.

219. And the reason that they have not been, as a matter of fact, is because the County Councils declined to contribute?—Yes.

220. But the theoretical idea is that District Committees should be there, and the Fishery Board should also be there, but the District Committees have not been created?—No, they have not. That is an Act of six years ago.

221. (*Professor Herdman.*) That has brought out what I was going to ask, whether a combination of the two was possible and desirable?—That is rather a complicated question.

222. May I put it this way: Do you think that it is an advantage to have, as you have in Scotland, all the work under one authority?—The purely scientific work?

223. Yes?—I think it is, rather than having it broken up under 12 or 14 Committees, unless there was some method of organisation. I think it would be found, if several different Committees were doing the work, just as they wished to do, then I think that that would not be quite so economical or satisfactory.

224. Supposing scientific work, say investigation work, were organised in England under one Board, do you think it necessary that the administration should also be under that one Board?—I think it would be preferable.

225. That the investigations and the police work ought to be under the same authority?—It is not the police work so much that I am thinking of as the statistics.

226. But that might be part of the investigation?—It is chiefly the statistics.

227. Have you any technical instruction to fishermen in Scotland?—No, but we are going to give it.

228. Under the Fishery Board?—I am going to begin it next year at Aberdeen.

229. Should it also be under the same authority as the scientific work and the administrative work?—I think with a matter of that kind technical instruction might very well be left almost entirely to the County Councils. At Aberdeen I am going to give demonstrations to the fishermen on condition that we get £200 from the County Council to build tanks.

230. Supposing you had an efficient boat for investigation, such as you described, of the nature of a steam trawler, would you consider it well to place her at the disposal of the international scheme, or do you think that you could employ her more usefully otherwise in the interests of Scottish fisheries?—I do not think that one boat would do for the international scheme and for the Scottish fisheries. Do you mean if one steamer was given to us whether it would be advisable to give up investigations for Scottish fisheries, pure and simple, and devote it to the international programme?

231. To a part of the international programme?—She might do part of the investigation.

232. You should consider that the best use to which you might put her?—No, I do not think so.

233. You think you could employ her more usefully independently of the international scheme?—Except, of course, there is always an advantage in having an international scheme in working internationally.

234. You mean that you could correlate work?—

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Yes, but the international scheme refers only to one coast.

235. About this sheet which you have laid before us, you told us that compared with five years ago it showed that the flat fish catch was changed on the grounds. Now is that owing to a better differentiation of the different kinds of fish?—No, it is the change of ground.

236. Is the difference to any extent owing to that?—No, they are very well differentiated at Aberdeen, and have been for many years.

237. You spoke of not having a chemist on board, if you were equipping a steamer. Do you mean by that that you do not consider the hydrographic part of the work is of so much importance?—I do not.

238. Do you consider that it is of any importance?—Well, it has this importance: It is advisable to have as thorough a ground-knowledge of the conditions of the sea as possible; but if a certain amount of money was to be spent on investigations for fishery purposes, I should be inclined to devote the money to what appears to be most immediately practical, rather than to what may only be of value by-and-by.

239. Do you consider that the hydrographic work done of recent years has had any practical bearing on fishery questions?—You know it has been done in this country largely by the Scottish Meteorological Society with reference to herring, and also by the Dutch Board, and I think by the Board of Trade, but as far as I know no practical result has come from that. But Ekman and Pettersson's researches seem to favour the view that the movements of shoals of herring and mackerel are correlated with the temperature and the currents.

240. Do you agree in that opinion?—I should think it likely enough, but I do not think that it is proved.

241. (*Professor Thomson.*) I have just a few questions to put. I have a difficulty about these statistics, which are doubtless very valuable. Many of these trawlers go out, do they not, for three, and four, and five days?—Yes, the number of days and the number of hauls is given.

242. But do they not complete their tanks from different localities?—But that would be given. They rarely do that.

243. But in each case on your sample tabular form there is only one locality?—But in that case they would fish entirely in the one locality.

244. And you could rely upon that?—Yes.

245. The importance of these statistics depends upon the accuracy of the locality?—Yes, the general accuracy.

246. I should like to press a little further a question suggested by Professor Heidman. Do you think that there are really many fishery problems which can be called distinctively local, whose solution in one area would not be of value elsewhere?—You mean there is, taking it on the other side, a large number of investigations that might as well be done in one place as in another place: Is that what you mean?

247. Supposing you gave a year's work at Loch Fyne and got valuable results, do you think that these would have no valuable practical bearing on the fisheries of England?—They might or might not; they might have no bearing whatever. For instance, one of the most important things to discover is the distribution of immature fish in the North Sea. That obviously is a thing which can only be done by going over the different areas, and any investigations of fact in a particular locality would not necessarily apply elsewhere. But there are investigations which might be as well done in one place as in another.

248. Then with regard to the North Sea exploration you first said that you thought it was a very good thing, and afterwards you said that it did not seem of immediate importance?—The hydrographic part of the programme, was it not?

249. Yes, perhaps. And then you said, after all, even after five years, you thought we would be practically where we are now?—From the practical point of view; my opinion is that if this programme is carried out as it stands, at the end of five years if you approach foreign Governments to negotiate an international agreement you will not have evidence to support the contention, and to convince them, that the fish have diminished. You will not have independent evidence from this scheme.

250. But if, apart from that there is gained during the five years some understanding of what the Germans call the "metabolism" of the North Sea, would not that be of enormous practical value?—In what way?

251. In understanding the whole question?—Yes, ultimately; but some other countries think that it is selfishness to some extent on the part of England to desire restrictions in the North Sea, and you require to convince all those countries by a very important body of evidence that a convention is necessary, and it must be a very important body of evidence, because according to the constitution of the Central Council, they can only recommend international action when it is the unanimous opinion of the Central Council that it follows clearly from the international investigations—it must be unanimous. Now, there are eight or nine countries, and some of them are very little interested in the North Sea. It is page 20, paragraph 4, section 3, that I quoted. Now, it seems to follow from this that if one country, such as Belgium or Sweden or Russia, disagrees they cannot make any proposal for international agreement, and that is a strong reason why the evidence and the necessity of international action should be so convincing. But according to this scheme at present the evidence about whether the fish supply is going down or is stationary or increasing depends upon the trawling of these scientific steamers, and they have all this other biological and hydrographical programme to do. Supposing there were two steamers for this country, one for Germany, one for Norway and one for Denmark, they could not in five years produce that information, even if they devoted themselves entirely to it.

252. (*Chairman.*) I have one question on a subject we have not yet touched upon, and that is on hatchery work; have you any experience of that?—Yes, we have carried on fish hatching for a number of years.

253. Have you had any experience of results?—Not definite. I may say that this question is being gone into just now; that is the result of the operations in Loch Fyne. The only definite result that I can so far see is that we have found the young fish on the beaches—that is, in the early stages, six weeks or two months after being put into the Loch.

254. You mean that you have found the young fish that were turned out as fry on the actual ground?—Yes, on the beaches.

255. The beaches being where?—On the natural ground that they frequent in Loch Fyne.

256. You are hopeful about the result as to that?—Considering the small expenditure—£250 to £300—the two things being carried on together, the fish hatching and the ordinary scientific work, we are hopeful, but the question is to be very carefully examined into soon.

257. (*Mr. Archer.*) Do you know the result of Professor Hensen's experiments with regard to the pelagic eggs in the sea?—No, I could not at present state the result; I am acquainted with his observations.

258. He has been investigating by the quantitative method, I think?—Yes.

259. Do you know the quantity he has found in a given area in the sea?—I cannot at present say.

260. Could you obtain information regarding the distribution of fish by the statistical scheme you propose?—Some information certainly.

261. Valuable information?—Yes, valuable information.

Mr. E. W. L. Holt, called; and Examined.

Mr. E. W. L. Holt.

262. (*Chairman.*) You are scientific adviser of the Fisheries Department of the Board of Agriculture?—I am scientific adviser to the Fisheries Branch of the Department of Agriculture and Technical Instruction for Ireland.

263. You have been good enough to prepare a statement which it would take you some time to go through: would you like to hand it in to be printed as your statement and your evidence?—Yes, I think that would be the simplest way of dealing with it.

264. Are there any special points in that statement which you consider important to bring under the atten-

tion of this Committee?—I think I have expressed my opinion pretty clearly upon the particular matters discussed in that paper. I have not paid very much attention to the question as far as it affects England.

265. Then we may put in that statement?—Yes.

The statement is as follows:—

In my opinion it is essential that the staff entrusted with the prosecution of fishery research should be an actual part of the Fishery Authority, and, therefore, for so long as the fishery authorities for the three kingdoms shall remain distinct, I should regard the devolution of all fishery research to a central department as a grave disadvantage.

As a matter of business it is obviously convenient that the scientific staff should be in close touch with the administrative staff, since consultation between the two is a matter of frequent necessity and the delays of an inter-departmental correspondence are sufficiently familiar.

I take it that the direction of scientific investigations would in any case be governed by the requirements of the various administrative authorities, since it does not occur to me as probable that public money would, in the immediate future, be devoted to marine biological research of a promiscuous and purely scientific kind.

The fishery interests of the three kingdoms are diverse, one branch of the industry being predominant in one country, another branch in another, while each kingdom has at least some form of fishing peculiar to herself; and even when the same industry is of much importance to all three kingdoms the local conditions are extremely different.

This is so much the case that a series of researches carried on in connection with any one industry in one country would not, in any case that occurs to me, be likely to produce results of more than minor importance to the same industry in one of the other countries. It follows that if the interests of each country are to be studied, a staff of workers, laboratories, and vessels must be maintained in each country, and I do not see in what way a central department for the control of these would be an advantage.

The administrative authority in each kingdom is or should be much more efficient than one central department to give what direction may be necessary, from the point of view of the economic aspect of affairs, to the scientific work in that kingdom, and could, undoubtedly provide clerical assistance in that work more cheaply than a central department, and I see no reason to suppose that a central department would be conspicuous for such knowledge of local conditions and requirements as is absolutely essential for the useful direction of scientific work, which must be regarded as ancillary to the administration and development of the fisheries.

It is not too much to say that a central department, independent (as in effect it must be whatever the nominal safeguards) of the local fishery authorities, might quite possibly, in endeavouring to adjust the interests of the three kingdoms, devote most of its energies to the conduct of researches of equally little importance to all three.

Where, as in Ireland, there is necessity to maintain a vessel or vessels for protective service, the protective and scientific work dovetail into each other at a considerable saving of public money.

It may be considered that a central department would be useful for the purpose of collating the work from all our coasts. I believe that independent bodies, in consultation with each other, would be able to put forth their results in such a form that no collation would be necessary.

One of the gravest difficulties of centralisation would be the tendency to reduce the local workers to mere recording machines, a position which no worker of experience would tolerate.

It is certainly undesirable that the scientific staff of each kingdom should pursue researches without any reference to each other, and whenever England acquires a scientific staff I think the heads of each staff should meet together every three months or so for the purpose of consulting as to how far it might be possible to harmonise their work so as to be of mutual benefit and to avoid overlapping. To my mind such a consultative body would do all the work of a central department much more efficiently and without any of the expense.

The members would know exactly the requirements and the assets of each kingdom for fishery research purposes, and would always, I imagine, be able to arrive at as much community of action as was desirable.

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While avoiding the centralisation of authority in the direction and conduct of research, I am in favour of the creation of a central fund for meeting certain expenses of common interest to the three kingdoms. Such expenses would be the translation and printing of such foreign fishery reports as may be recommended by the heads of the scientific staffs in each kingdom. Many such reports contain matter which should be easily accessable to everyone connected with fishery administration, and not a few would be found of value to persons commercially interested in the fisheries. I think it most unlikely that difference of opinion as to advisability of translating any particular report would arise.

Another branch of expense which could easily be defrayed out of the same fund would be the naming and in some cases the quantitative analysis of such organisms as absolutely necessitate the employment of a specialist in their particular group. I may mention as an instance the Diatomaceæ, a group of great importance in the interpretation of surface drift. The Committee is well aware that nowadays there can be no such thing as a general biologist even approximately reliable up to the extent of our present knowledge in all groups. To attach a specialist in each obscure group of organisms to the staff of each kingdom would be very expensive, even if enough specialists could be found or trained, while it would be a matter of comparatively trifling cost to employ competent people to work out collections of particular groups sent up from the different kingdoms.

It may be urged that this is a strong argument in favour of centralising the whole thing. It is in reality nothing of the sort as most of the groups require working out on the spot; and the above suggestion is only intended to refer to a very limited number. The function of the central worker would be to name the organisms, tabulate their relative number and forward returns to the staff from which the collection came.

ORGANISATION AND EQUIPMENT.

1. Ireland.

So far as Ireland is concerned I think we are hampered only by want of funds—that is to say, it seems possible that the monies available for fishery purposes may not always be found adequate for both economical and scientific work.

The organisation is of a reasonably workable nature. The fisheries constitute a branch of the Department of Agriculture and Technical Instruction for Ireland. The head of this branch is a permanent administrative officer, responsible to the department for all the work of the branch.

Attached to his staff is a scientific adviser, who has a staff of assistant naturalists, laboratory attendants and fishermen. In the clerical staff of the office is a technical assistant, whose duty it is to look after the clerical work connected with scientific matters, with the aid of the ordinary clerks.

The duties of the scientific adviser are, generally speaking, to recommend to the administrative officer research on such lines as appear advisable, and, if such research is approved by the Department, to carry it out and report results. Any questions involving expert scientific knowledge are referred by the administrative officer to the scientific adviser, and if the latter is unable to supply the required information at once he takes steps to obtain it, by local inspection or experiment as the case may require.

The scientific adviser has an office in the Department, and it is proposed when the Department get their new buildings to provide him with a laboratory there. He has a laboratory on the west coast in connection with certain researches—life history of mackerel and movements of salmon in the sea, etc.; attached to the laboratory is a large fishing boat and a flotilla of small boats. The steam cruiser "Helga" is fitted up for all kinds of fishery research, and is available for work wherever required. It is hoped that the staff may be strengthened by the appointment of an assistant naturalist, who will live on the "Helga" and carry out routine observations on given lines, as the various calls on the time of the existing scientific staff urgently demands such an arrangement.

I am quite prepared to propose additional equipment for more efficiently attacking the various fishery problems with which we are faced, but as far as the scheme of organisation goes I think that if it fails to

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produce good results it will be the fault of the persons concerned and not of the scheme.

The devolution of work to local agencies is not practicable in Ireland.

2. Scotland.

So far as I know the only vessel at the disposal of the scientific staff is the "Garland," and I can say from personal experience that she is utterly unfit for serious fishery research.

3.—England.

In England fishery research at present appears to be hampered both by want of funds and by want of organisation

I think the difficulty could best be met by placing a sufficient fund in the hands of the Board of Trade, to be administered by the fishery authority, in consultation with, say, a representative of the scientific workers of the Liverpool district, a representative of the Marine Biological Association, and a representative of the east coast. It would be necessary, I think, to establish a laboratory with proper equipment of vessels and staff on the east coast, which might either be directly under the Board of Trade or indirectly.

As to the other coasts it seems advisable to make use of existing scientific institutions, with due control as to work and expenditure."

266. You are opposed, I think, to any scheme of centralisation whereby the three national departments should be worked as one?—I am opposed to any scheme that would separate the scientific work from the administrative work, because I am convinced that both would suffer greatly thereby—certainly the scientific work would.

267. (*Mr. Spring-Rice.*) With refsrence to that point you lay special stress upon combining the scientific with the other work. I believe that in Ireland you combine not only the scientific work with the practical work in that form, but in the form of protective work, do you not?—Yes, it is possible to do that.

268. The "Helga" is used for scientific as well as for the other work?—Yes.

269. And do you find that successful?—It acts very well so far.

270. It does not interfere with the other functions?—Not with the scientific work in the least.

271. When you speak of the national differences which justify keeping up three authorities and three scientific branches for the three kingdoms, may I draw your attention to the case of the Irish Sea, including St. George's Channel?—Yes.

272. Is there anything in the Irish aspect of that area from the point of view of sea fishing which differs from the English or the Manx interest?—Well, the interest of the English is to get into the bays on the Irish side, and the Irish interest is to keep them out.

273. Leaving out the three-mile limit, the territorial limit, in the open sea?—Yes, but the English trawling interest in the Irish Sea is a very large one, and for the present our steam trawling interest is only at its birth; we have four or five steam trawlers, and probably we shall have more.

274. The most of the Irish trawlers are sailing trawlers?—Yes.

275. Looking at it scientifically, is there anything to justify two sets of researchers studying the problem in these waters?—No. In the arrangement which I suggested there would be a consultative committee between representatives of the three countries. One thing that I imagined would certainly have to be settled would be in whose hands should be the exploration, or whatever it might be, of the Irish Sea, or how we might divide the ground so as not to overlap. That is a case where two could work in harmony.

276. You agree that there should not be two investigators in the same area?—Not acting without each other's knowledge.

277. Then as to the subjects of investigation I am very glad to see that you recommend some sort of joint body to settle programmes of work. Would you be afraid of saying that each of the three national authorities should decide to drop some problems and adopt only others for that field?—If it is a case of large problems I think they could probably arrive at an understanding of that sort, but I find from my experience, apart from large pieces of work, that there is constant employment in small matters which one continues to follow without attention to one's neighbours, as such things would not concern them.

278. I was thinking of larger questions—for instance, the herring is proverbially the great fish in Scotland; do you think that the English and Irish Boards might fairly be asked not to give any special investigation to the herring, leaving that to Scotland so far as it is required?—We have our own small herring problem in Ireland, and the local conditions are considerably different I think what would probably happen in such a case as that the Scotsmen would ask us to look after certain investigations with regard to herring in our own country, and no doubt they would give us very valuable information as to the lines on which it might be pursued.

279. So that you would not be prepared to leave one sort of fish alone for investigation purposes?—I do not say that, I think that the Scottish scientists would find it more convenient to leave the outlying places—such as the West of Ireland—for us to deal with, unless they are more powerfully equipped than at present.

280. But would you regard that as a local problem? Why would it not be better to study it broadly in one place for the benefit of the United Kingdom?—Certain parts of the herring problem might be, but I do not know how the result of local enquiries would be everywhere applicable.

281. You would recognise that on the whole it would be desirable if you have three authorities that each one should concentrate its attention on comparatively few problems?—Yes, it is a matter entirely of the funds available.

282. The fund is sure to be limited?—I am quite sure of that.

283. Do you or do you not think that it is the best way of spending limited funds, dividing it among three bodies, that the subjects of research should also be divided between the three bodies, each leaving alone what the other undertakes?—Theoretically I admit it, but it is not a matter on which you can generalise.

284. Not to generalise absolutely; but would you be prepared to lean in that direction?—Supposing, for the sake of argument, I was representing Ireland in such a conference as I propose, my own opinion would certainly lean in that direction.

285. (*Mr. Crawford.*) Assuming that the administrative organisation remains as at present, do you think there would be any economy in centralising scientific problems?—Not much—the reverse I should say.

286. You consider that the existing scientific staffs would be just as much required?—Yes.

287. And would get less assistance than they now have, being attached?—Infinitely less; they would have much fewer opportunities of obtaining knowledge of local conditions and of practical matters in general.

288. Then with regard to what Mr. Spring-Rice asked you, am I right in thinking that your opinion is with regard to the distribution of subjects for investigation, that it would be better to leave that to mutual arrangement between the three bodies than to prescribe it for them from outside?—I think it would be much better to leave it to mutual arrangement.

289. Do you think that there ought to be co-operation and conference?—As far as possible there certainly ought to be, to avoid waste of money.

290. (*Professor Herdman.*) I have one or two questions to put to you that I asked Dr. Fulton about. Do you think that we can get the information which we are all agreed, I suppose, is necessary, by means of this international scheme?—No, I think not, as far as I am acquainted with it.

291. I think you have worked personally, have you not, at the small fish in the North Sea from Grimsby?—Yes.

292. So that you are acquainted with the problem. Do you consider it is a great advantage to have what is called the international treatment of that question, to the English fisheries?—That means the protection and closing of certain defined areas frequented by these fish?

293. I mean the investigation of the grounds in order to have further knowledge as to the distribution of these little fish?—I think I know a good deal about it myself; I have investigated it for some years.

294. Do you think it sufficiently investigated?—For all practical purposes. There would be no harm in further investigation.

295. Do you think that England has much to gain by an international investigation of these grounds?—No, I think that the gain is purely problematical. It might convince foreign nations that it is desirable to close them, and if it did convince the nations England would be the gainer. But it is purely problematical. I think we have quite as much information as we want on that point.

296. Then with regard to the work of general investigation at sea, how often have you considered it necessary to take observations on a ground in order to obtain just conclusions as to the populations there?—My own proposals with regard to the Irish Sea were to trawl over given areas for a certain period once every two months as far as practicable. Once every three months would probably suffice, but I think that the intervals must be at least as often as every three months for most trawling grounds; once every three months and make an extensive series of hauls.

297. Do you consider that monthly trawling would be better?—Yes, but it is hardly practicable except on very limited areas.

298. Does not that depend upon the number of vessels and the number of localities?—Precisely it does. The number of vessels is likely to be limited.

299. What area would one steamer take—take the Irish Sea?—Once every three months, I think, one powerful steamer such as ours could do it fairly well. It would be better if we had two. That is leaving the same steamer some time for other work.

300. Do you mean for police work?—For that and other branches of scientific work in which she is engaged.

301. Supposing it had no administrative work to do, supposing it was for purely scientific purposes, could you undertake the whole coast of Ireland or is the east coast as much as could be done when getting the information you consider desirable as to the population of the sea in the interest of fishery questions?—No, because you need different types of boats for the whole question, and a trawler will tell you nothing about mackerel, and you would want a steam drifter for that purpose. Preferably two, because it is so difficult to change the different kinds of nets.

302. Would you supplement your steamer by employing some smaller boats?—No, a drift boat is as big as a steam-trawler or pretty nearly. It would be as big as a small steam trawler.

303. Then you would require two steamers?—I think one steamer for the trawling and one with a large number of tow nets for drifting operations. We have at present only a large sailing boat for drift-net investigations, and to do it thoroughly we ought to have two steam drifters. We get help from the Congested Districts vessels, which are always going up and down the coast, and keep records.

304. Now as to interfering with the work, I understood you to say that the scientific work was not interfered with when the steamer took also other duties—administrative duties?—I meant to say that she finds time for both.

305. But may she not be required to do something else just at the time that she ought to be taking a scientific investigation in order to complete the series?—A day sooner or later makes very little difference in that matter. It has happened in my experience when surveying the ground that a telegram has come that a steam trawler has been misbehaving, but it has not made any difference, we have got back in time to do what was wanted.

306. Do you consider that the fisheries interest of the three kingdoms is diverse?—Yes.

307. Do you know the state of affairs in England, the District Committees and County Councils?—Some of them.

308. Do you consider that a satisfactory state of affairs for scientific work?—It seems to depend very largely on the personnel of the Committees.

309. I see in your typewritten statement that you think such work would not be practicable in Ireland?—No.

310 I want to know does that opinion extend to England also?—Oh, no. I excepted Ireland purposely as we have absolutely no local bodies who carry on any scientific work in Ireland. It is certainly desirable to use the English Committees as far as possible, but the difficulty is that they cannot work on continuously. Popularly elected bodies are apt to change their minds like other bodies of people.

311. Do you think that it would be an advantage in England to put the District Fishery Boards under one central authority?—I think it would be.

312. That would be divorcing the administrative from the scientific work, which you have told us should not happen?—I do not think so. At present the administrative work is done by itself.

313. By the District Committees?—I am speaking of headquarters more.

314. Is it not in the hands of the District Committees?—The scientific work is in the hands of the District Committees. I think I misunderstood you; I thought you were speaking of the central fishery authority, and not of the district authority.

315. At present in England it is in the hands of District Committees. If you put that in the hands of a central authority, then the two would be separated?—I think it would be possible to come to a workable arrangement whereby the Central Fishery Board could work on certain lines through the local committees, still leaving them their interest in their particular lines of research, whereas the central body would retain certain powers of control.

316. Do you think that the central body could make use of local organisations, local laboratories and marine stations?—I believe so.

317. Do you think it ought?—Yes, I think so, with due control.

318 What do you mean by due control?—I mean to say that a subsidy may be given to a scientific association to carry out work in connection with the fisheries, and it may be given in perfectly general terms. The result may not be satisfactory to the Fishery Authority.

319. (*Mr. Archer.*) I have a few questions to ask you with regard to the area over which you think one steamer could probably work. Do you not find that there is considerable difference between the quantity, the description, and size of fish in one trawl to what there is in another on the same ground, in the same season of the year?—Precisely, you can make two trawls alike, and they won't fish the same.

320. And you would therefore require a number of observations of the same grounds in order to get a fair average as to the distribution of fish on that ground?—Yes.

321. Have you got any figures to show, or could you tell us at all what number of trawls you think you would have to make, over one ground, in order to get a fair sample of the distribution of fish on that ground?—Of course, that depends upon the size of the ground, and fishing grounds vary enormously in size.

322. I am taking the line or the area trawled over, not the contiguous ground at all?—You are speaking of a defined line over two points.

323. Yes, over which the trawl works?—Yes; I think in the defined line about half a dozen hauls would yield reliable results, but if you confined yourself absolutely to one line you would probably miss your fish, because they move about a good bit on the tide, and other things disturb them.

324. Half a dozen trawls, would that mean about six years' work?—Half a dozen trawls in six years?

325. Yes, do you mean one trawl at each three months?—No, I meant half a dozen trawls at each three months

326. Then how many years would you have to continue that?—I should think we would get pretty reliable information in ten years; we might get it reliable in five and we might not.

327. At what intervals apart ought these trawls to be made?—Not more than three months.

328. At what distance apart?—You cannot possibly speak as to that, because different areas of ground that you wish to explore are of such very different characters.

329. Have you anything to show that a ground of one character, or water of one depth, would give similar results?—The only work I know in that direction is Dr. Allen's, which you probably know. He goes in

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330. At present you have not sufficient data to answer such a question?—One has a very fair idea upon the subject, but one does not like to insist upon it.

331. In the sea, for instance, have you thought at all where you would place your stations?—Yes. I have not a chart except this little thing. There seems to be about five main fishing grounds in the Irish Sea—one close up to Clogher Head, and another, speaking broadly, off Dublin, and the third off the south-east corner here (*showing a plan*).

332. Is it from the fishermen that you get the information as to the whereabouts of the fishing grounds?—All the information I have at present is from what I know and from what I have got from the fishermen at different times of the year; but to a less extent, one makes cross trawls across barren grounds in the hopes of striking anything, and we are tabulating the nature of the bottom ground.

333. But you do not know of any scientific data which would show how a trawl made on two areas where the conditions, as far as possible, are the same, would give similar results?—Approximately similar results.

334. Have you any scientific data which would bear that out?—I know the records of my own trawling with the results on the same line, and the results have been approximately similar. I used to do it repeatedly in Cawsand Bay in Plymouth, and I used to trawl over one particular line. The variation was not enormous except with the season on the same line.

335. But, then, do you trawl over any other line where, as far as you knew, the conditions were similar and find similar results?—I have known the other line that I trawled yield different results where the soundings were very much the same.

336. Did you hear Dr. Fulton's proposals with regard to the collecting statistical information with steam trawlers in the North Sea?—I think I know what it was—I did not hear it.

337. Do you think that valuable statistical information with regard to the distribution of the fish might be collected in that way in order to show you where you should work with your special steamer?—Of course, one has reasonable doubts as to the veracity of the steam trawler's skipper. But Dr. Fulton was apparently quite satisfied on that point. If you are given veracious results and fairly accurate detail as to the quantity and as to the position of the fish, then it certainly would be the greatest help in the world.

338. Do you think it would be a good plan to put a special man on board these steamers in order to collect the information?—Yes, it would be absolutely necessary if you wanted to get the information correctly.

339. Because, of course, by working by special men like that you save the expense of the steamer, and you would be able to get more extensive results for the same money?—The results would be confined to certain details. I have been out in steam trawlers a good deal myself, and the skippers have been always good in giving every possible facility; but I had to restrict myself to certain matters to prevent interfering with their work and decreasing their returns.

340. Could you get information with regard to the distribution of fish?—As far as the trawl is an efficient method of discovering fish, yes.

341. And that you were able to make tow netting trawlings yourself?—Only a rude sort. Of course, the vessel wanted to go sometimes at a speed which did not suit my tow nets.

342. (*Professor Thomson.*) About the diverse interests of localities, at the foot of page 1 of your notes there is a very strongly worded sentence to the effect that a series of researches carried on in connection with any one industry in one country would not be likely to be of more than minor importance to the same industry in other countries?—Yes.

343. Is not that exaggerating a little the importance of locality; if one found out in one locality some particularly good method of hatching lobsters or multiplying bait, would not that be of great importance elsewhere?—In matters of that sort it might, but such matters are, to some extent, dependent upon local conditions.

344. (*Professor Herdman.*) In connection with the evidence that you gave as a result of Mr. Archer's questions as to trawling along a line, do you not think that you might often substitute the area of line with advantage, and talk of it as an area?—Taking it as an area and averaging a number of trawls inside that area?

345. Define an area on the chart, taking as far as we know the same physical conditions, and take your trawlings over that area, and not necessarily on the same line?—That is what one would be inclined to do, but the area would consist of a number of lines, and as far as possible one would try to adhere to the same lines. But it is not possible in the open sea.

346. Would it not be better to talk of it as an area rather than as a line?—(*No answer.*)

347. (*Mr. Green.*) You have been saying something about steam drifters. I want to know how you think your present equipment would be benefited if you had *carte blanche*, for instance, to carry out the investigations in that life history of floating fish and ground fish all round the Irish coast so far as steamers go—and as to craft?—We certainly want a naturalist to be constantly on board, as we find the difficulty in placing a man there when there is a lot of work. In regard to floating fish, one sailing boat is so much dependent upon weather—it is stopped either by storms or calms—that the substitution of steam would give us infinitely greater results. Sometimes we can get no result for three weeks at a time—there may be a calm or a storm.

348. Would these steam drifters be available for tow nettings?—Yes.

SECOND DAY.

Wednesday, 23rd October, 1901.

PRESENT:

The Right Hon. Sir HERBERT MAXWELL, Bart, M.P. (*Chairman*).

WALTER E. ARCHER, Esq.
DONALD CRAWFORD, Esq.
The Rev. WILLIAM SPOTSWOOD GREEN.
Professor WILLIAM ABBOTT HERDMAN, F.R.S.
The Hon. THOMAS H. W. PELHAM.
STEPHEN E. SPRING-RICE, Esq., C.B.
Professor J. ARTHUR THOMSON.

R. E. MARTYR, Esq., *Secretary*.

Mr. GEORGE COX BOMPAS, called; and Examined.

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349. (*Mr. Crawford.*) I think you are prepared to give some evidence about the Buckland Museum of economic fish culture?—Yes. I have prepared a statement on that subject, and if you please I will read it.

350. I believe you are a relative of Mr. Frank Buckland's?—I am a brother-in-law of Mr. Frank Buckland.

351. And you have taken an interest in this museum from the first?—I have.

352. Will you read the statement which you have prepared?—The terms of reference appear to admit that the problems affecting the fisheries of Great Britain and Ireland require scientific research, and are entitled from their importance to State aid. The inquiry is as to the best means by which the necessary assistance can be given. I desire to direct my evidence to the consideration of the Buckland Museum of Economic Fish Culture as an important and indeed necessary element, both of scientific research and practical fishery instruction.

353. I see that that statement is somewhat longer than we anticipated. If you have no objection the usual course would be to hand it in, and it will be put on the notes?—If you please.

354. (*Mr. Spring-Rice.*) You have given us a summary of it. Would that not be sufficient to examine you on?—That is only just the heads of it, and some of the documents I need not read at length. The statement was supplied to the Chairman, and I think it would be necessary to go through the material part of my statement.

355. (*Mr. Crawford.*) The Committee are of opinion that you should read it?—It seems plain that every technical industry to which scientific research is applicable must need a storehouse or museum in which the results of that research and of practical experience shall be preserved and exhibited in visible records, and it is equally plain that such a museum once formed should be constantly developed and kept up to date, if it is to fulfil its purpose. It is now generally acknowledged, although this country has been behind some other countries in realising it, that technical instruction is necessary for the development of our industries, and to this rule the fishing industry is no exception. This museum has for its primary object technical information and practical instruction in relation to our fisheries. The origin of the museum was as follows:—Frank Buckland, the donor of the museum in question (the son of Dr. Buckland, Dean of Westminster) was appointed one of Her Majesty's Inspectors of Fisheries in 1866, and continued to hold that office until his death in December, 1880. The office had been created in 1861 upon the Report of a Royal Commission appointed in 1860 to inquire into the causes of the decline of British Salmon Fisheries, which had already become extinct in some rivers, and were failing seriously in most of the salmon rivers of England and Wales through neglect or mismanagement. Frank Buckland's energy and enthusiasm greatly contributed to the preservation of the British salmon fisheries, and he conducted in a like spirit and to the public advantage many official inquiries in relation to the British sea fisheries, such as the questions of oysters, crabs, and lobsters, and other inquiries. He ever strove to impress both on the Government and on the public the practical importance of our river and sea fisheries as a source of food supply, the fish yearly sold in the London market alone being numbered by hundreds of millions, and forming a large part of the food of both rich and poor. To aid the practical study of fish and fisheries, and teach people through the eye (the quickest method) their practical value, Frank Buckland formed, at his own expense, this fishery museum; cast for it, mostly with his own hands, 400 specimens of fish, and collected a large number of objects illustrating fish and oyster cultivation and preservation, and the modes of taking fish. The purpose of the museum was thus described by Frank Buckland himself in 1868 in his second report as Inspector of Fisheries: "Being exceedingly anxious that the public should have a good idea of the nature and importance of the British salmon fisheries, I am happy to be able to report that I have got together a museum of economic fish culture, and my collection is open free to the public at South Kensington. The natural history of the salmon as well as of other products of the waters of economic value, especially the oyster, is illustrated by plaster casts and preparations, all of which I have made myself, and mostly at my own expense. There will be found in my museum models of salmon passes and modes of salmon capture, nets, etc. The process of hatching the ova of salmon, trout, etc., is also carried on at the gardens on a considerable scale." This museum, the fruit of great labour and expense he bequeathed to the nation, "Upon trust, that the same may, under the name of 'Buckland's Fish Museum,' be for ever devoted to the use of the nation, and form part of the national collection at the South Kensington Museum for public instruction and enjoyment, under the regulation of the authorities for the time being having the direction or control of the said last mentioned museum." He also bequeathed £5,000 after his widow's death to found a professorship of Economic Fish Culture in connection with the museum. Some portion of this legacy has been lost by the default of a trustee, but stocks of the value of about £4,500 are held by the Court of Chancery upon the trusts of Mr. Buckland's will. The gift and its conditions were formally accepted by the Department of Science and Art in 1881. This Department, whose special province is the application of science and art to purposes of practical utility, had for some time previously given space for the exhibition of Mr. Buckland's collection amongst the collections connected with the mining industry, inventions, food products, art manufactures, and other kindred subjects, and the collection has ever since been exhibited at South Kensington.

356. (*Chairman.*) Can you give an example of any local organisations?—The following letter expressed the opinion of Sir Richard Owen of the proper use and value of the museum:—"British Museum, July 1st, 1867: My dear Buckland,—I have always regarded the morning I was favoured to spend with you in the inspection of your Museum of Economical Fish Culture at the Royal Horticultural Society, South Kensington, as one full of interest and instruction. The museum, both by the nature of the well-selected contents, and their arrangement, appeared to me to be a valuable means of impressing upon all concerned or interested in the improvement of fisheries, and especially of the salmon rivers, the best and most appropriate and successful measures to that important end. I believe such a collection would be a most valuable appendage to the Salmon Fisheries Commission and Office, or should be so situated and administered as to be at the command of the Commission. Make whatever use of this opinion you may think best in the interests of the great national source of food in which we have both felt much concern, and believe me, sincerely yours (signed) Richard Owen." Frank Buckland stirred up throughout the country an interest in our fisheries, the effects of which survived him, and may be traced both in many local organisations for the cultivation and preservation of fish, and in the remarkable Fishery Exhibitions held in 1881 in Norwich, in 1882 in Edinburgh, and in London in 1883. It led to Fishery Commissions being established throughout the country to a large extent. He excited an interest throughout the country, and fishing clubs and fishing organisations were established very much indeed owing to his exertions in that way. At the closing ceremony of the Fisheries Exhibition of 1883, His Majesty the King, then the Prince of Wales, spoke as follows: "I think our duty towards the supporters of the Exhibition will not be discharged until we have done something towards the promotion of that application of science to practice from which the fishing industry, like all other industries, can alone look for improvement." The Prince proposed the formation of a society having for its objects the collection of statistics and other information relative to fisheries, the diffusion among the fishing population of a knowledge of all improvements in the methods and appliances of their calling, the discussion of questions bearing upon fishing interests, and the elucidation of those problems of natural history which bear upon the subject. Such a society, as the representative of the interests of the fisheries, would naturally take charge of the scientific investigations which bear upon those interests, and would, no doubt, His Royal Highness said, be brought into relation with the already existing Fisheries Museum of the Department of Science and Art, which is founded on the collection bequeathed to the nation by the late Mr. Buckland, but which had been enlarged and enriched by the liberality of many of the exhibitors. Numerous exhibits from the exhibition of 1883 were accordingly presented to the Buckland Museum; His Royal Highness the Prince of Wales deposited there a remarkable series of Indian fishes; the late Dr. Day gave a very extensive and valuable collection of British fishes, and a series of models of fishing boats of different nations was purchased from the exhibition at the request of the Department of Science and Art for £250 by myself for the Buckland Museum. Some purchases had previously been made by the Department at the Norwich and Edinburgh Fisheries Exhibitions for this museum, and a few have been made since. Part of the building occupied by the Buckland Museum was pulled down in making the Imperial Institute Road. A portion of the collection was then removed and stowed away in the vaults. The remainder of the collection has been

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exhibited in three rooms, now reduced to two rooms at the end of the West Gallery. In 1889 a committee was appointed by the Treasury to enquire into the science collections at South Kensington, whose report was presented to both Houses of Parliament at the close of that Session, and was also referred to the Select Committee of 1898, afterwards referred to. Shall I read the paragraph of the report? It recommended that the museum should be abolished.

367. I fancy we have all read it?—The 10th paragraph of that report refers to the Buckland Museum in the following terms:—"10—Fish Culture Collection—no mention of this collection is made in the departmental scheme of classification, dated January, 1888; and indeed it seems to bear little relation to the instruction given in the normal school, to the teaching in science classes connected with the department, or to the other sections of the Science Museum. Nor is South Kensington a situation naturally well adapted for fish-breeding operations. We beg to refer to the weighty opinion of Professor Huxley as to the want of connection between this collection, and its present surroundings, and the small educational or scientific value which it possesses in its present condition. The greater part of this collection was bequeathed to the Department in 1880 by the late Mr. Frank Buckland, and a series of British fishes have since that date been presented to it by Dr. Day. This state of things would, however, in our opinion hardly prevent the Department from transferring the collection to some other public institution. The Buckland Professorship, if the funds for its support are still available, might well be attached to the Marine Biological Laboratory at Plymouth, under regulations agreed to by the Science and Art Department. With the consent of the donors (when obtainable), some objects, forming part of this collection might find a place in the Natural History Museum; and the remainder might be transferred to the Marine Biological Association, and the Scotch Fishery Board, provided that those bodies are able and willing to receive them. In any circumstances we are of opinion that there is no necessity for the collection being retained at South Kensington, and certainly no provision should be made for it in any building scheme there." The evidence on which this report was founded stated, however, that the bequest had been accepted by the Government upon condition that it should be permanently exhibited at South Kensington, and further that the terms of the will had been very much neglected by the Department. Then what I call your attention to is that the report was said to be based upon evidence, amongst others, of Professor Huxley. Now Professor Huxley's evidence was this, and I rely upon this evidence. He said: "At the time the offer of the museum was made we were full of the Fisheries Exhibition, and there was a great deal of talk about something to be done for the fisheries."

358. Professor Huxley was then Inspector of Fisheries?—He was. He goes on to say: "If the Committee consult the concluding speech of the Prince of Wales they will see there a reference to a project for constructing a Fisheries Society which was to be endowed with a certain amount of the funds proceeding from the Fisheries Exhibition. Under those circumstances it seemed to me that if this Fisheries Society was going to be started it would be a very good thing to utilise the great amount of material which might have been obtained by making a Fishery Museum in which information could be got about all the fisheries and all the means and appliances, fishing models, fish passes, and all the rest of it. That would undoubtedly have been a very good thing. I had a notion that if this Fisheries Society was constructed, and if Mr. Buckland's funds turned in, then without any particular expense to the Government there would be the foundation for establishing a fishery organisation, which was much wanted then, and is wanted now. It was upon that ground that I, for one, recommended the acceptance of this collection. I think I ought to say that partly for the reasons mentioned, and on some other grounds the breaking up of the collection after it has been accepted by the Government would create a considerable turmoil in some quarters. My difficulty is that my opinion of the expediency of having a fish culture collection or a fishery collection remains exactly where it was if the means and appliances are forthcoming, and if the projected Fishery Society ever becomes a reality. It is not that I have the least doubt about the value of a museum of that kind. There was to have been connected with it an office for collecting fishery statistics. But the original project seems to have gone to pieces, and I cannot recommend the preservation of the collection as it is. My opinion was that there should be an office in this country, with its great fisheries, where anybody could get such information as he wanted about fisheries in general." Professor Huxley further stated that what he desired was a good collection of fishery appliances, and the means by which persons interested in the fishing industry could obtain what information they wanted on any particular subject; that this was a very old idea of his, as old as the time of the Fisheries Exhibition, and that it was a thousand pities that the plan that was once started and recommended by the Prince of Wales was not carried out. It, therefore, appears that the evidence on which that report was based maintains the utility of the museum, but asserts that its usefulness is not properly developed in proportion to the national importance of our fisheries. The museum has certainly suffered from want of due care since Mr. Buckland's death, but the importance of such a museum in connection with a Central Fishery Department is not less than when described and emphasised by Sir Richard Owen, Professor Huxley, and by His Majesty the King. The Board of Trade has now undertaken the care of the British Fisheries, and supplies, for England, the organization for the collection and distribution of information and statistics relating to the Fishery Industry which His Majesty the King and Professor Huxley pointed out as plainly required, and the bases of a like organisation for Scotland and Ireland is provided by the Fishery Boards of those countries. To extend the usefulness of the museum as suggested by His Majesty, and by Professor Huxley the co-operation of the Board of Trade, and of the Scotch and Irish Fishery Boards appears essential. It should, it is submitted, be made a part of the duties of the Inspectors of Fisheries in England, Scotland, and Ireland to preserve and deposit in the museum of Economic Fish Culture, any objects of permanent interest which may come under their notice, together with photographs or models of improvements in fish passes and fish culture, and also any apparatus and appliances of practical utility. By such means only can the museum keep pace with the progress of technical knowledge, and fulfil its purpose of practical usefulness growing with the growth of the science of economic fish culture. The Marine Biological Association which is subsidised by the Board of Trade might also be invited to deposit in the museum such specimens as are not required for use at the Laboratory. On the 29th July, 1898, the Second Report of the Select Committee appointed to inquire into and report upon the administration and cost of the museums of the Science and Art Department was presented to Parliament; it contained, at page 27, the following recommendation: "We recommend that the Museum of Fish Culture should be abolished. Previous recommendations to this effect have already been made. The secretary and the director both agree that it should be removed, and it has already been offered to two public bodies, being rejected by both. The fact is that this collection is dangerous, owing to the large amount of alcohol in which the fish are stored; it is obsolete, not having been revised or increased for several years; and it does not carry out its obligations under the testamentary conditions of Professor Buckland's will. It occupies a good deal of space. Opinion being unanimous, we hope that this collection may disappear without delay." The Select Committee was not unanimous. It consisted of fifteen members, of whom seven only approved the report, three, including Sir John Gorst, voted against it, and five abstained. No expert fishery evidence was heard. The only evidence taken in support of the recommendation appears to have been that of Sir John Donnelly and Major-General Festing, who, perhaps, not unnaturally, sympathised more with art collections than with fish culture or national food supply. In consequence of, and in answer to this report, a memorial was presented in 1899 to the Duke of Devonshire, the Lord President of the Council, and the Right Honourable Charles T. Ritchie, M.P., then President of the Board of Trade, setting forth in substance the facts I have stated, and praying, "That the Buckland Museum of Economic Fish Culture should be maintained and exhibited at South Kensington permanently, and in a proper and efficient manner, in accordance with the terms of the bequest accepted by the Department of Science and Art; and that such steps might be taken in accordance with the suggestions of H.M. the King, than the Prince of Wales, as might be deemed expedient for securing its permanent usefulness in the interests of

the river and sea fisheries of the United Kingdom." I have copies of this memorial, and I shall put in as many as the Committee desire (*handing in the same*). The memorial was supported by over 100 signatures, including 25 peers, 22 members of Parliament, 30 chairmen of Fishery Boards, 7 angling clubs, representing several thousand members, and the Prime Warden and other members of the Fishmongers' Company. The weight claimed for the memorial is due not to the mere number of signatures, but to the fact that, with few exceptions, the signatures are of representative men practically interested in our national fisheries, and the just inference is that those who are best acquainted with and most deeply interested in our national fisheries are practically unanimous in the desire that the Buckland Museum of Economic Fish Culture should be preserved and developed to full usefulness. Nor would the steps necessary for this purpose meet with political or party opposition, for the memorial is signed not only by members and supporters of the present Government, such as the Duke of Richmond and Lord George Hamilton, but also by the Earl of Kimberley, Sir William Harcourt, and Sir Edward Grey. On 5th February, 1901, a deputation of the memorialists was received by the Duke of Devonshire and Mr. Ritchie. The deputation was introduced by the Duke of Abercorn, and was supported by Sir Spencer Walpole, formerly a colleague of Frank Buckland as Inspector of Fisheries; by the Earl of Portsmouth, Chairman of the South-sea Fisheries District; by Mr. Martin, M.P., Prime Warden of the Fishmongers' Company; Mr. Travers, a warden of the Fishmongers' Company, and treasurer of the Marine Biological Association; Mr J. Willis Bund, Chairman of the Severn Fishery Board; Mr. William Senior, Editor of the *Field*, and ex-president of the Flyfishers' Club; the Honourable Cecil Duncombe, Chairman of the Yorkshire Fishery Board; Mr. Marston, Editor of the *Fishing Gazette*; and Mr. Charles Patterson, Secretary of the Sea Anglers' Society. These speakers urged the national importance of the fisheries, estimated by the Board of Trade at a value of nine or ten millions per annum at wholesale price, and giving employment to more than 100,000 men, and relied on the opinions expressed by His Majesty when Prince of Wales, by Professor Owen and Professor Huxley, and the numerous and weighty signatures to the memorial as evidence of the necessity of the maintenance and proper development of the museum. In reply, the Duke of Devonshire said that he was not indifferent to the very great magnitude of the interests represented. That without expressing any definite conclusion as to whether it might be possible for South Kensington to continue to give a home to the museum, he did not think that Department possessed the kind of expert knowledge which would be required to a proper development and management of such a museum as this. The Duke further said that it was very much to be regretted that no practical effect had been given to the suggestion of His Majesty when Prince of Wales for the formation of a Fishery Society similar to the Royal Agricultural Society. Failing this, and assuming that Government assistance should be given to the development of the fishing industry, and to the maintenance of a museum illustrative of that industry, the matter was one much more for the consideration of the Board of Trade than for his Department. That he hoped Mr. Ritchie would consider whether his Department could undertake the custody and development and further progress of this museum, and if he should be able to press any measures for this purpose on the Treasury, he (the Duke) would be most happy to give him all assistance in his power. Mr. Ritchie said he had listened with very great interest to the speeches on a matter of the very greatest importance to the whole community. That if Government were so foolish as to neglect and to care little for such a great industry they would be very unworthy of the position they occupied; for he could conceive of hardly anything more important to the working classes of this kingdom than the development and increase of the production of a food which is so essential to them, and which ought to be so cheap. That the Department presided over by the Duke might not be sufficiently staffed with technical advisers as to enable it to deal thoroughly and completely with this question. On the other hand, the Board of Trade has the fisheries under their control, and are responsible for everything connected with the fishing industry, and if some means could be provided by which the museum could be properly housed at South Kensington or elsewhere, and the working of the museum and other matters connected with it should be entrusted to the Board of Trade, they would be very glad to undertake the work upon the necessary condition that they should get the support of the Treasury for the necessary increase of staff. I put in a full report of the proceedings on this deputation, printed in the *Fishing Gazette*, which will repay perusal (*handing in same*). The importance of our fisheries as a national industry needs no stronger argument than the language used by the Duke of Devonshire and Mr. Ritchie on this occasion, and it is affirmed by the high authorities already cited, and, indeed, seems to follow, that technical information and instruction and a museum to make visible and to record the facts relating to this industry must share its importance. This museum, founded thirty-three years ago by the energy and originality of Frank Buckland, was the first of its kind, and its example has been followed by foreign countries, especially by the United States, which has shot far ahead of us in its care and development of fisheries. Ichthyological research and the practical management of fisheries require a training for all concerned, and Mr. Willis Bund, the chairman of the large Severn Fishery Board, explained, in speaking at the deputation, his personal experience of the importance of a museum where the different and most improved forms of fish passes, nets, turbines, gratings, and all other matters connected with fishery can be seen and compared. Without it those who are to have charge of our fisheries, from the members of Fishery Boards down to the water bailiffs, must have difficulty in acquiring the necessary training. They cannot acquire this by intuition. The Board of Trade now hold periodical meetings in London of the heads of Fishery Boards. The museum should contain illustrations of the latest information and improvements, so that all those controlling the many Fishery Boards should be kept abreast of the results of experience and research. I believe it to be the practically unanimous opinion of those best acquainted with our fisheries, and who have considered the subject, that this museum ought to be maintained and fully developed, and that to abolish it would be a retrograde step, a token not of scientific progress but of decadence. The Americans, a practical people, attach very high importance to their fisheries. They have imitated but outstripped us in their large and admirable fishery museum, which is a branch of the National Museum at Washington (where I have seen it). It is added to and kept up to date by the collections made and transferred to it year after year by the United States Fisheries Commission. This Commission unites on a larger scale the functions of our Board of Trade Fishery Department and of the Marine Biological Association, together with fish culture and distribution on a large scale. The United States expend annually about £70,000 on their Fisheries Commission, maintaining two small steamers and a schooner, and conducting twenty-five fish culture establishments, which distribute annually 500,000,000 of small fish.

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359. Is that the United States or the New York State Commission?—The United States Commission.

360. Is the expenditure of such a Commission as the New York State in addition to that?—Yes, there are different State Fishery Departments as well, but the Government relies chiefly on the United States Fishery Commission, and also on the Scientific Department, which has control of their museum; and then by the National Commission from time to time—every year, in fact—hundreds of exhibits are made over to the Fishery Museum, so that it is kept up to date; and in addition to that many of the States have Fishery Departments of their own.

361. The point I wish to bring out is whether these twenty-five fish culture establishments are in the hands of the United States Government or of the States Legislatures?—I am quite correct in saying that those are in the hands of the United States Government. I took this from the United States report, and I remember it said that besides the Government Fishery Commission there was fish culture carried on in different States as well.

362. Yes, but is it by the individual States?—They do have them, but the Fishery Commission is the United States Commission, and I am correct in saying that this I have mentioned is extracted only from the report of the United States Commission; and is in addition to any fish culture by the different States.

363. Do you mean that there are fish hatcheries under the Central Government running side by side with those of the separate States?—So I understand. As the doubt has been raised, I will verify it; but I am satisfied I

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am right in that respect. The late Mr. Matthias Dunn (who died a few weeks ago), in an article in the "Contemporary Review" of July last, quoted a letter to himself from one of the United States Fishery Commissioners on the practical importance of artificial fish hatching, as follows:—"The result obtained in this country (America) by the artificial propagation of food fishes has not only been encouraging, but is phenomenal. No person informed on the subject now disputes the fact that the future of our fisheries must depend for its prosperity in a measure on artificial methods of hatching. The shad fishery, which had become depleted to a remarkable extent, has by artificial propagation steadily increased, and amounts to upwards of a million dollars a year, notwithstanding the fact that the abundance has made it possible for the fishermen to sell at lower prices than formerly. These fish have been introduced on the Pacific Coasts, where they were indigenous, and they have multiplied to such an extent along hundreds of miles of coast that they are now common fish in the markets."

364. Then they were not indigenous?—I think they were indigenous; and then they had gone out, and then fish culture restored them. I am not quite certain.

365. I think you want the word "not" before "indigenous" there?—It should be "not indigenous to the Pacific Coast, although, in the Review, the word "not" is omitted. The United States Report shows that shad are not "indigenous" but "introduced" on the Pacific Coast. "As regards the cod, it is only recently this work has begun, but now they are found in enormous abundance in the neighbourhood of our hatcheries, in many places where they had never previously been seen in the memory of the oldest fishermen, and in such numbers that a profitable fishery has been maintained from them by a fleet of small vessels. The fishermen confidently look forward to seeing a fishery built up off the New England shore in the near future, which will be beyond anything men now living ever witnessed." Mr. Matthias Dunn urged that like steps should be taken to replace fish on those parts of our coast where they are failing, and also that more energetic steps should be taken to check the destruction of immature fish, and to cope with the fishes' enemies. All these are subjects requiring illustration in the museum. Nor is the wholesome recreation of many thousands of anglers to whom this museum is a source of unfailing interest a matter to be despised. If the preservation and development of the museum may be assumed, where should it be housed? It has been exhibited for thirty-three years at South Kensington. Its bequest was formally accepted by the Government upon trust "that it should be forever devoted to the use of the nation, and form part of the national collection at the South Kensington Museum for public instruction and enjoyment, under the regulation of the authorities for the time being having the direction and control of the last mentioned Museum." At the date of the bequest and its acceptance, the Science and Art Department was the only Government Department having charge of applied science and museums in illustration of it. The mining industry was, and is, under its charge. The School of Mines, with the co-operation of another kindred Government Department, the Geological Survey, has built up at Jermyn Street a geological museum of admirable completeness. At South Kensington a large collection of mining machinery and appliances is now exhibited. Food products, the principles of agriculture, with models of agricultural machines, and the various insect pests which beset agriculture are scientifically illustrated in the museums of this Department, and multifarious manufacturing exhibits formed, and still form, part of the South Kensington Museum. There was, therefore, nothing incongruous in the bequest or its acceptance. A Government Fishery Department having now been created, efficiency and good sense dictate that the Fishery Department should now have or co-operate in the direction and control of this museum, but there is, it is submitted, no ground for depriving the museum of the home assigned to it for thirty-three years. No other position can be readily suggested so convenient to the Department, or so useful to the public. Of the four rooms originally assigned to it one was destroyed by the Imperial Institute Road, another has been recently taken away, and should, I submit, be restored. Any growth of the museum in future may be conveniently and inexpensively provided for, either by building an additional storey, or by building a gallery alongside the existing rooms, and for this space should be reserved. If the Fishery Department should find an immediate enlargement necessary, some appropriation should be made out of the existing grants for the reconstitution of the South Kensington Museum, in which this is an element. Without seeking to emulate the expenditure of the United States Government (though the United States Government deem it remunerative), such moderate expense as is necessary for the proper care and development of our fisheries, and the food supply they provide for rich and poor, ought, it is submitted, to be allowed. With regard to the organisation of the Fishery Department, the last subject of the reference to this Committee, I would only observe that the views expressed by His Majesty after the Fisheries Exhibition of 1883, and the other opinions cited, point to the advantages of a central office in which all information should be finally concentrated, and of a central museum in connection with it.

366. (*Mr. Pelham.*) Was Professor Huxley interested as much in sea fish as in river fish?—Yes, he was an inspector of both. I mean officially he was equally interested in both.

367. You say Professor Buckland took an interest in both?—Yes.

368. Is the museum as useful for sea fisheries as for salmon and other river fish?—Probably the salmon river fish would be the more important, but it is useful for both. It contains, for example, a very large collection of oysters from different places, and with the different substances to which they adhere, a matter to which Mr. Frank Buckland paid a great deal of attention, and which up to that time had been hardly explored. There is a large collection of them and of crabs and lobsters—those are sea fisheries to which inquiry was directed, and there are a number of specimens illustrating scientific knowledge in those matters.

369. Are there any specimens of flat fish, and their food?—Some; not so much in the way of food. Those are things which should be added to it. Fish passes and those things are illustrated up to the time of his death, and they would require much in the way of additions.

370. Can you speak generally as to what the nature of the later additions to the museum have been?—Since the Exhibition of 1883 I notice there have been a few specimens of preserved fish added. That is all, I think. At that time there were a good many added.

371. Are there specimens of all kinds of fish?—There is a very large collection. Dr. Day gave a very large collection of British sea and fresh-water fish in spirits.

372. You do not suggest that there should be live fish put there, I suppose?—Well, the question of fish culture is perhaps hardly for me to express an opinion upon. I think that it would be very desirable that what was exhibited from the beginning, namely, the mode of fish hatching should be continued, because although that is done now by private individuals in various parts of the country, there are many who want to establish fish hatcheries on their own rivers who have no means, except by going to their neighbours, of finding out about it, and I think there should be fish hatcheries to show how it should be carried on, and it would be desirable to have it here, as has been done until lately. The public in general do not really, unless they have paid attention to it, know anything at all about it.

373. You consider that the present collection is a valuable asset?—I think so. It is a nucleus of a valuable museum.

374. Are the specimens in good condition?—Fairly good. They have not been taken very good care of, but they are fairly good. They may require re-varnishing.

375. Is there room in the building for further development?—No, not without building another storey or adding another room.

376. Something was said about this being a place of great interest for anglers?—I think so.

377. That is fresh-water anglers?—Yes.

378. Do many of them visit the museum?—A great many.

379. Is there any record of the number of visitors?—That I cannot tell. I think they are not taken separately from those who pass through the other parts of the museum, but I cite the fact that seven British

angling clubs have signed the memorial who represent many thousands of anglers, and who certainly express a very strong interest in the museum, and desire that it should be carried out and improved.

380. And it is important in your opinion that this museum should be in the actual place where experiments are carried on?—No. I think it should be where it is most accessible to the public and to the Board of Trade, and those who have to look after it. It was once suggested that the museum might be taken down to Plymouth, for example. I went to see the biological laboratory there, to which I subscribe, and I found there was not room for anything that had models. There was no space for models of fish passes and other fishing appliances, and very few people would see it there.

381. Is it your idea that the museum is valuable for fishery experts, or rather for the public generally?—For both.

382. I mean supposing scientific experts are inquiring into the condition of the North Sea, would that museum be of use to them?—It is very desirable that they should have access to it.

383. Have you any estimate as to what the ordinary cost of maintenance at present is?—I have no knowledge of that.

384. Is there a caretaker or two caretakers?—There used to be an old servant of Mr. Frank Buckland kept on there for many years, and he was superannuated, and since he died I do not think they have had a separate caretaker.

385. There are two rooms, I understand?—There were three rooms until quite lately, and now there are two. I think the Board of Trade would have to consider what was necessary to be done to enable them to take proper care of it.

386. Is it your suggestion that if samples were obtained from the bed of the sea in the course of inquiries that those should be added to the museum?—Yes, and with regard to river fisheries, especially models of weirs and fish passes, and such like things, it ought to be kept up to date. I was told at a more recent fishery exhibition at South Kensington—Fishing and Yachting—which took place four or five years ago, there was a suggestion that exhibits should be borrowed from this museum, and it was found that they had not kept it up to date, and this was a matter to be deplored.

387. (*Mr. Archer.*) I have only one question. I think you said that Professor Huxley was Inspector both of Sea and River Fisheries?—Yes.

388. Was he not Inspector under the Home Office?—Yes, he succeeded Mr. Frank Buckland.

389. Is it not the case that sea fisheries were not attached to the office of inspectors until the inspectorate came under the Board of Trade?—If that is so I may have been misled by knowing that Mr. Frank Buckland made various inquiries with regard to sea fisheries, but I suppose they were special inquiries.

390. (*Chairman.*) Mr. Archer is talking of Professor Huxley?—My answer is in that way, because Professor Huxley succeeded to Mr. Frank Buckland's office, as far as I know, without change, and I know that Mr. Frank Buckland made various inquiries as to sea fisheries.

391. (*Mr. Archer.*) Probably what you are thinking of was that Professor Huxley held a number of inquiries also into the sea fisheries?—Yes. I was not aware of the terms of the Commission. I am much obliged to you for correcting me.

392. (*Chairman.*) You spoke of the preponderance of the fresh-water specimens in the museum over marine specimens?—There are many of both; my impression is that there are more salmon and trout than sea fish, but I am not sure.

393. Does not that arise from the greater facilities at Mr. Frank Buckland's disposal for obtaining fresh-water fish?—Possibly. He was certainly more occupied at the time when he was appointed with salmon fisheries. They were dying out, and the necessity of visiting the rivers and providing fish passes was very urgent, and no doubt for a long time his chief duty was to look after the salmon fisheries. Perhaps I may correct myself, and say no doubt there is a greater variety of sea fish, and I am not certain whether the greater variety of sea fish may not over-balance the greater number of specimens of salmon and trout.

394. How is the bequest of £5,000 of Mr. Frank Buckland administered in Chancery?—It is in Chancery, and the income is paid under the terms of his will.

395. It has nothing to do with the maintenance of the museum?—No. On the death of the widow it belongs to the museum.

396. Then you spoke in your statement of the co-operation of Scotland and Ireland?—That is towards the end of page 28.

397. The co-operation of the Board of Trade and of the Scottish and Irish Fishery Boards is essential in your opinion to the maintenance of this museum?—The proper maintenance. Yes. It seems to me that unless there are three museums for the three countries, which I think would be an unnecessary expense, that the central museum should have the advantage of such specimens as are added to it from all the three kingdoms. But so long as there are three Departments for the three kingdoms it should be maintained with the co-operation of the three departments.

398. You quote from the report of the Select Committee of 1898?—Yes.

399. Which recommended the abolition of the museum of fish culture?—Yes, I think that was founded upon imperfect information for the reason that I gave.

400. What was the main ground for that?—Obviously I think that they thought that the room for the Fishing Museum was better than its company; they wanted the room for other purposes.

401. They wanted to get hold of the premises?—I think so.

402. Do they state that in their report?—Well, it says, "It occupies a good deal of space." That is the last sentence of their recommendation in the report.

403. What was the reference to that Committee?—I have the reference here. It was appointed, as you will see, "to inquire into and report upon the administration and cost of the museums of the Science and Art Department," and there were a large number of inquiries and questions as to the Art Department having been properly carried on, and there was a great conflict at that time upon those subjects, and this is merely one detail of the Report. As the administration included this museum they had specially to consider what space was necessary, and how space could be provided for the already over-crowded exhibits, and they made merely as one detail of a very long inquiry which I think comprised two blue books, this recommendation.

404. It is hardly fair to ask you, but how do you reconcile the last sentence quoted—"Opinion being unanimous, we hope that this collection may disappear without delay," and then your comment is only seven out of 15 members approved of the change?—I can only account for it by saying that at the particular meeting of the committee when this resolution was come to there were only seven members present and voting. That may account for it, but certainly the Report was only carried by the votes of seven members. Sir John Gorst and two others voted against it, and five did not vote for the Report. I rather think that is how the inconsistency must have occurred. It was an irregular attendance, and extended over a long time, and this was passed by the votes of seven members only.

405. Well, the general opinion expressed in your evidence is that there is an obligation on the State to maintain this museum?—I humbly submit so.

406. And that the most useful place to keep it would be in London?—Certainly, that is my conviction, and that opinion you see is shared by all those who signed that memorial. They are not merely names, but names of those largely interested in our fisheries, and they all concur in that. May I mention that if you desire my individual opinion to be confirmed the Fishmongers' Company, who take an official and important interest in these subjects, would be very willing to attend and confirm what I have said as to their view? Mr. Travers, who was Prime Warden when that memorandum was signed, said that he would be very willing if invited to do so, to express his opinion.

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407. (*Chairman.*) We should like to have on the notes the usual professional description?—I am Professor of Zoology at the Royal College of Science and a Fellow of the Royal Society.

408. Are you connected in any way with the Buckland collection?—None whatever, officially. I am a servant of the Board of Education, but I have no official connection with the Buckland collection of any sort or description. I can only speak of it as I know it.

409. You have known it for some time?—I have known it for a great number of years. I have known it for considerably over 20 years.

410. Perhaps you would state whatever you think would be of use to us?—I sent in a statement concerning its having been thrown into the Fisheries Exhibition as an annexe. In 1883, at the time of the Exhibition one of the partition walls was broken through, and for the year of that exhibition the public had free entrance to the Buckland Museum. Then, I go on to state that on the cutting of the Imperial Institute Road a portion of the building containing the collection had to be sacrificed. I believe I heard Mr. Bompas refer to that fact just now, and that it was inevitable, but the collection was in no way destroyed as the immediate result of that, but simply condensed.

411. A good deal of destruction was involved in that?—There has been destruction involved, but I have made very careful inquiries, and the destruction does not seem to have been to any considerable extent that of specimens hanging, except for some which almost dropped from the walls. But even in Mr. Buckland's time I understand some of the specimens were stored in an old glasshouse which was not even rain-proof, and they became mouldy and were destroyed.

412. I see you speak of a young whale, and of the baby hippopotamus Guy Fawkes?—Yes, I ascertained what exactly they were.

413. Neither of them fish?—Not exactly, but the interesting thing is that one is still in existence elsewhere. As far as I can ascertain from what the officials tell me, there was no place to hang these particular specimens on the wall. They were larger than those now hung, and for that reason they were left, and the weather got hold of them, and they grew mouldy, and were perfectly useless.

414. Then there are a number of fish casts?—Yes, a great number at present are hanging.

415. Is that a valuable collection?—I should say only to a small degree. The larger number of the casts are certainly not of any great value. I have instanced such as the specimen of a fish "killed by a water-wheel." It is a cast of a fish with a deep indentation at the place where it was struck. I think from no conceivable point of view can that be of great use. The same applies to fish fighting which have been beaten in battle, with red indentations to indicate the precise points where they were seized. That, to my mind, is a useless exhibition. And then, again, with fishes described as "condemned in the market." There are one or two casts of these, each an *omnium gatherum* of fishes just as condemned by the inspector, cast as they lay. They show nothing beyond the fact that there was a slab of fishes condemned on the day to which they refer. But I should say that subject to a more careful overhaul than I have been able to give them casts of that kind are valueless. They seem to me to teach nothing.

416. But there are casts which are of value, are there not?—Yes, there are some, particularly the finished casts of the salmon; those are faithful representations of nature, and they would certainly bear remounting, at any rate in part, and certainly those are valuable. Some of the casts of fishes too bulky for preservation, dry or in spirit, would be useful if kept, for all Buckland's casts are accurate at all times. Then I have memoranda on the casts of fish ovaries, and of fish with the ovaries laid out. On some of them, at any rate, the number of ova counted is recorded and engraven in the plaster slab, and they seem, as far as I can make out, to have been the basis of some notes that Mr. Buckland published on that question, and they might conceivably be worth keeping. But they are very poor as casts. There are one or two casts of cod's ovaries just as they lay in the dish, and that is about all, except the record in the corner of the number of ova which they bore.

417. All this work has been done over and over again?—Certainly, a good deal of it.

418. I mean the counting of fish ova?—Yes, that has been done by other people.

419. Then you have a large collection of preserved fish in spirit?—Well, the Buckland collection of preserved fishes is a very poor affair. There are 100 to 120 bottles, and they mostly contain stages in salmon fry, and things of that kind. But without going into them critically, I think there are one or two fishes among them which are comparatively rare, and, therefore, might be kept; but taking them *en bloc*, they are such a collection that anyone having access to eggs of salmon and coarse fish, which are not of great novelty, could get wholesale.

420. You have something to say as to the methods of preservation?—They are simply preserved in spirit, and some of them were so badly preserved that the officials were compelled to destroy them. Having kept the bottles with the decomposed spirit as they were left, the contents became so abominable that they fell to pieces for want of proper preservation from the first; but how many of them met that fate I do not know.

421. It is not a collection to which you would like to introduce Dr. Dohrn, of Naples?—Oh, no. There is not a specimen there which is of great value.

422. Then you have models of salmon ladders and passes?—The few that are there are in fair condition, but they are antiquated, and my conception of them is that if they are used for any future purpose they might be put into a series which would have to be formed—they are quite out of date. Allowing for their ancient design, they are in fairly good condition. There are about a dozen of them in all.

423. Can you mention any other features?—The most attractive, from the purely æsthetic point of view, is the collection of poachers' implements.

424. Are those for educational purposes?—No, I do not think so. As far as I can make out, most, if not the whole of them, were collected by an Irish magistrate, whose name does not appear on them, and he presented them to the Buckland Museum through Mr. Ffennell. The custodians of the museum have devoted care and attention to them, and everything has been done in the way of attracting the public; they have been labelled, and comparatively recently they have been remounted and put into very good order, and from the æsthetic point of view they are the central point of attraction in the museum at the present day. There is no sign of rust on them, and the instruments are of the typical order. They are displayed to perfection, and duplicates have been put away in a dry cupboard and carefully preserved. But as to their scientific value, that cannot be high.

425. Are the hatchery tanks in use?—Yes, there is a small hatchery of a series of slate tanks with running water, and for some years past that has been in regular use with satisfactory results. And in the middle of the room there is a nursery to which the young fry are transferred from time to time, various people—I do not know exactly who they are—by applying in the past have been presented with young fishes and salmonidæ reared there, and some of them are still living. But the hatchery is a small affair, with running water, and they purchase the fry from one of the Surrey hatcheries every year, and that has been done ever since the place was in existence.

426. From what source?—The Board of Education purchase the fry, they get it from a place near Haslemere—the Surrey Trout Farm. They have been in the habit of purchasing about £5 worth of "eyed ova," as they call it in the trade.

427. Who looks after it?—There is an attendant. When I first knew the place there was a man named Eden, who was Mr. Buckland's own man, who had charge of it, and he was paid by the Science and Art Department. At his death a man named Fox was put in charge, and he is assisted by a bottle-washer, who keep it clean. But this man Fox is permanently employed by the Board of Education at the present time, and you can hardly call him the custodian. He ranks as an attendant upon the official list, and is generally in attendance in the section of the Museum in which the Buckland Collection is located.

428. Were specimens of nets to be seen?—They tell me that the majority of the nets of larger size fell to pieces when the condensation of the museum took place, and had to be destroyed at once; they would not stand moving, the accommodation was so bad up to that time. But the only nets they have now are models. There is one case nearly the size of this table (*indicating*) with a series of nets of which I have given a list, all carefully preserved, and they are accurate models. And beyond that there are models of trawls, which are part and parcel of the series of fishing boat models, which are very good. But of actual working nets there are none. The nets left there by the late Mr. Buckland decomposed by the attacks of fungus.

429. And Mr. Buckland made a collection illustrating oysters, did he not?—Yes, a very extensive collection, but I do not think there is anything in it of any real scientific value. There is a great accumulation of shells They are in sloping wall cases two-thirds the width of this table, and the collection is broken up into two or three parts, for no reason that transpires, unless it be want of room for better display. In all there are about 100 feet of case room filled in that way. But the shells are arranged in a very irregular way. There are some models of oysters which are inaccurate and perfectly useless; and the great attraction to the public is a bottle and a piece of leather covered with oyster shells, and things of that kind. I should not attach to that collection of oyster shells any importance, because it is a thing which could be got very readily in a better and more modern form. There is nothing to show the leading stages of the development of the oyster. There are a tile and one or two spat collectors which are covered with shells, but the shells are in an advanced stage, and scientifically they are useless.

430. Technically there is some significance in the different texture of oyster shells?—That may be, but they want going over and sorting, and examining carefully to see what is there. However, this bulk of them I am sure are useless.

431. Then as to the remaining collection what do you say?—Well, as to the crustacea there are two colossal lobster-claws which have been described before; but claws have been obtained in America of greater size But beyond that there is a fairly large specimen of a rock lobster, and one or two specimens of crabs of a very commonplace order. The only thing that recommends them is their size, and one or two might be worth retaining. The bulk of them are in a very bad state, and some of them, in the hands of a preparateur, have been smeared over with varnish which has spoilt whatever natural beauty they ever had.

432. What do you say of the miscellanea?—They are poor. There are a few dried star-fish which are falling to pieces, and mingled with them are three young turtles. It is perfectly obvious that one or two of the shells which have pearls exposed must have had something to do with an attempt to form an exhibit bearing on pearl fisheries or pearl formation. But there is no definite history attached, and the case is but an *omnium gatherum* such as anyone arranging a museum could put together.

433. In short the whole collection is a sort of thing that an industrious and practical naturalist could put together for his own purposes?—Yes, of the Buckland type, which is of the phenomenal and curious in natural history. But the bulk of things which are of real use, are no part of the original collection.

434. What are those?—Well in the first place there are a series of stuffed fishes—large fishes and not of British origin, and I fail to find out exactly how they came there. But from what I can ascertain they were purchased after the Fisheries Exhibition—that is to say between 1883 and the present time by the Science and Art Department as an indispensable part of a collection of something else. They were not bought in any sense of the word with a special view to the Buckland Museum, but being stuffed fishes and decently stuffed, they were put in a case, and placed there—that is all I know about it. Their history seems to be involved, but they are no part of the Buckland collection, and they were not purchased with a special view to the fisheries. They are mostly large fishes.

435. What have you to say about the Day Collection?—That is pre-eminently the most valuable thing there. Though not complete it is a good collection of fishes, which Dr. Day presented conditionally on their being properly mounted. They were mounted by Mr. Saville Kent, and presented carefully sealed down, and the mounting has been of a very costly character—because the jars were expensive. These, again, have suffered from the action of light, but they are a decently representative collection of the British fishes, and some of them appear to be the fishes upon which Dr Day has written in his great book on the subject. They are of value, and I have been privileged to use them now and again during the last fifteen years in my class lectures, where they have been of great service for the purpose of study. But there is nothing original or scientific in them which could not be seen in the adjacent Natural History Museum. They form the most popular scientific attraction of the collection as far as the casual visitor is concerned. Then there are a lot of stuffed fishes which are beneath consideration. There are a great number of them, and some were purchased from the Norwich Exhibition. The majority of them have been purchased by the Department from a Mr. Gunn, of Norwich, and later from a Mr. Sachs. They are the kind of thing one sees in an angler's shop. The fishes themselves are decently stuffed, but most of them are in boxes with glass frontings, and as for the mounting there are grasses and artificial flowers which have no association with the fish. The fishes themselves are certainly worth better treatment, and if the cases were destroyed and the fishes remounted by some person who knows the surroundings of the fish, and who could represent them in their natural habitat they might be interesting But as at present exhibited they are perfectly contemptible.

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436. So far as they are of value to students of ichthyology do they ever overlap with the British Museum?—Well, they do, and they do not. At the British Museum if you wanted to see one of those British fishes such as would be preserved in Dr. Day's series, you would have to go into the spirit room. As an exhibit open to the public they do not overlap but the same species would be accessible by inquiring at the British Museum, and they would be in larger numbers.

437. Besides the ichthyological specimens there are some models of fishing apparatus, and boats, are there not?—Boats in particular. They I take it are a valuable collection, and officially recognised. Although placed in the Buckland Museum some of them are placed there by the desire of the donors, but others of them, which are the property of the Museum, are placed I think for convenience sake, and they are all carefully described in the catalogue, of which I have given the name. They are definitely recognised as part of the Victoria and Albert Museum collection of naval models, and described at length in an official catalogue under the heading, I think, of "Barges and Boats." The curators, the officials of the museum, recognise these as part of their collection, and catalogue them, and give them every special attention, whereas such curatorship as the Buckland Museum receives is taken by the museum officials in the ordinary course of their work except that a man who is rather more of a custodian than a technical expert has the care of the Buckland Collection, and takes it as it comes. That is to say, there is no effort made to curate the Buckland Collection apart from the rest of the museum.

438. But the Buckland exhibits have been labelled and arranged?—Yes, they have been arranged. Subsequent to the cutting of the Imperial Institute Road, and quite recently in fact, while they were making a new communication between two of the museum sheds, which exist in the neighbourhood, the Buckland Collection was for the moment taken down pending these structural alterations. The things have been put back in their places with greater order than before, and in putting them back they have been carefully gone over and cleaned.

439. Do you think that there is a good nucleus for an instructive museum?—There is a small nucleus. I would not say that the whole collection were useless. Taste varies for example, and certain of the casts might very well be kept, but the nucleus of really serviceable materials—that is a very small one. And my conception of it is that if a fishery museum were established, and the Buckland Collection were used as part of it, the best things in the Buckland Museum could but fill the gaps in a series which would have to be bought, or manufactured, or obtained elsewhere But there is certainly a nucleus of specimens which it would be desirable to keep.

440. Have you considered the desirability or probable utility of a Central Educational Museum of Fisheries?—Well, I do not see why such a thing should

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not exist. You mean a museum for the education of the public?

441. For instruction of the public?—For the instruction of the public rather than for distinctly scientific purposes. You mean an educational and not a working scientific establishment.

442. I meant connected with technical instruction?—There is no question that a very large section of the British public take an interest in fishery matters, and they would welcome the foundation of a fisheries museum, but as Professor Huxley said in his evidence before the previous Commission, it would have to be altered lock, stock and barrel. It is perfectly certain that the present building is absolutely useless. Only one morning last week I was standing there getting out these data, and rain came through the roof. The building is worse than a shed as it stands.

443. Would you say that a museum in London is more desirable than one at Plymouth, for example, or in Ireland and Scotland also?—If I were asked for an opinion upon the question, I should say that a museum and bureau should be at some headquarters of some kind in each of the three kingdoms. I think they have each a right to expect it.

444. When you speak of a bureau do you mean a sort of thing like the Fishery Department of the Board of Trade?—Something I take it for administrative purposes. If the Fishery Department as it now stands constituted were strengthened by the appointment of a scientific adviser, which I believe there is not at present, that ought to be sufficient for central administrative purposes. I am not a practical fishing man, but looking at it from a general point of view I should recommend a central establishment for each of the three kingdoms, and that the first step towards the actual development of the work would be to strengthen the hands of some of the existing institutions on the coast. For example, there is no question that under the guidance of the present director, work of the right order is being done at Plymouth, but if you go to Plymouth they are handicapped for the want of boats. If I had to make a recommendation I should say that one of the best steps would be to make, perhaps, Plymouth the central establishment for England, and give them a fleet of boats.

445. When you talk of a scientific adviser to the Board of Trade, what do you mean?—I mean a man who has had practical experience of fishery affairs from a scientific point of view, a man who has studied the movements of fishes, and the habits of fishes in relation to their movements, about which we know very little. That is what I mean.

446. Is it not the case that the whole question of fish movement and life depends upon fish food, and therefore instead of one scientific adviser you would require a staff of specialists?—But then it is assumed that a properly trained adviser would possess that knowledge.

447. Of a staff of specialists?—Not of a staff of specialists, but one who would know sufficient of fishes to systematise. My idea of the central establishment in London would be that the chief head should control the movements at all points on the coast, and that the work which is done should as far as possible be correlated and simultaneous. It is perfectly certain that this is one of our desiderata. A great deal of work has been done by great personal enterprise, and at great sacrifice, but it is work confined to localities. What is desirable is that observations of a uniform type should be made simultaneously at all points of contact with the sea. That seems to be a reasonable proposition, and it should be the function of persons at headquarters to secure its adoption.

448. What I want to call your attention to is your somewhat vague term of a "scientific adviser"?—By "scientific adviser" I mean a man who is something more than administrative, and who has been trained, or by training has acquired a knowledge of fishes, and all that concerns fishes.

449. That would imply not only an ichthyologist, but a bacteriologist, pathologist, etc.?—But you would not touch the pathological side. That is a special department. What do we know of the movements of fishes?

450. (*Mr. Crawford.*) With reference to the last question I would like to ask you some questions as to the Fishery Board of Scotland, whether that is the sort of thing you mean?— Do you mean the work they are doing there?

451. No, with regard to the scientific advice. The Scottish Fishery Board consists of seven members; there is one scientific member unpaid; we have also a scientific superintendent who is a paid officer, and he gets occasional assistance from young naturalists?—Of that I am quite aware.

452. And we also have an Inspector of Salmon Fisheries?—Yes.

453. Is that the sort of thing you mean?—That is the sort of thing, only if I may instance the work of the Scottish Fishery Board, as far as I am familiar with it, the great desideratum there is boats. I should say that a staff constituted much on the lines of your present staff with an adequate fleet would be a good thing, but so far as I read your reports and understand them, you are rather handicapped for want of boats.

454. That is so?—That is your weakness. And for that reason if Plymouth were made a head centre for the British coast I would give Plymouth a fleet of boats to start with, and I would give Professor Herdman a seaworthy steamer at Piel, to say nothing of the Isle of Man.

455. With regard to the museums I rather gathered from what you said that for the purposes of instruction one museum would not be sufficient?—One would like to see a museum in each of the three kingdoms.

456. Supposing in the matter of fish passes, which is an important thing, you had a museum in Plymouth and in London they would not be of much use to people in Ireland, for instance?—Certainly not.

457. (*Mr. Pelham.*) I did not quite understand as regards the various items you mentioned how far they referred to sea fish or fresh water fish?—You are speaking of the Buckland Collection?

458. Yes?—The bulk are fresh water—there are many sea things—but I think I am right in saying that the bulk pertain to fresh water fishes.

459. The hatchery tanks, are they for salmon?—Yes. They have been given over to the Loch Leven trout. Sir James Maitland's fish and one or two odd fishes at different times. The Loch Leven is the fish mostly reared, and four or five live there now, but they do not look at all happy.

460. What would you say about Dr. Day's Collection; what does it consist of?—That is a fairly representative collection of British marine and fresh water fishes. It is not complete, but it is such a collection as the student would require for his first introduction to the study of the group.

461. I have no doubt you are aware of the recommendations of the Hydrographic Conference?—No, I am ignorant of them.

462. But as regards the inquiry as to flat fish, their habits, their distribution and their food, would the museum be of use at the present time?—As constituted, certainly not.

463. There is nothing which illustrates the food of fish?—Not to my knowledge—I think not, except an occasional fish swallowing another. For example, there is a fish trying to swallow a fish bigger than itself, and there comes in the sensational. But there is nothing that one could call scientific.

464. As to the models of trawls, where did they come from?—The boats were given by various persons. Of the fishing craft and nets that are there, some have been lent, but most purchased, and some were given by Mr. Bompas for incorporation in the Buckland Collection. But a large number of them have been bought by the museum authorities.

465. Are you aware whether the trawls are up to date and of the newest inventions?—The trawling boats I should say are not. Those I have in mind go back to the eighties, and the trawling has been very much improved since that time.

466. If a central museum was formed as you propose, would it be useful for research purposes or merely for educating the people?—It would be of great value for research where you had running hatcheries if you had proper control, and I certainly could make use of it for research.

467. Do you lecture on these subjects?—I lecture on the structure of fishes.

468. Do you refer your pupils to this collection?—The Day Collection. I have lectured on fishes on several occasions to students, and Mr. Holt, who is now in Ireland in the service of the Fishery Board, attended a course of lectures on fishes which I gave, which was partly illustrated by Day's Collection, and this made a fishman of him. His work dates from that done in my laboratory with Day's fishes on the table.

469. Is there anybody as far as you are aware in South Kensington interested in developing the museum?—As Professor of Zoology I am aware of its interest to zoological science.

470. I mean on the staff of the museum?—There is not. The general feeling of the staff of the museum is that as a branch of the museum as at present constituted it is rather out of its element.

471. There is no body who would be very much on the look out for gifts or purchases for it?—Oh, dear, no.

472. (*Mr. Green.*) Do you think that the presence of the fish in this collection visible to the public is of importance compared with the British Museum, quite apart from class teaching?—The British Museum is primarily a store-house, and I do not think that it is the duty of its staff to collect fishes directly for the public. Their first task is the storage of all forms. But in a fisheries museum you should certainly have a complete series of all forms which are indigenous, so that a person could identify specimens. You should have of the indigenous fauna a well-preserved series of fishes always at the public gaze.

473. Yours is invisible?—Yes.

474. And you think that the public should have another series?—Yes.

475. The public would thus not be dependent upon the Buckland Museum?—That is the question. Is it a function of the British Museum to exhibit a collection of local fishes?

476. (*Mr. Spring-Rice.*) With reference to some questions which have been put to you I should like to ask you whether an improved collection of this nature, supposing it existed, would be of importance to you in your duties at the college?—I should certainly avail myself of it, and I should be glad to have a hatchery as a means of securing research work.

477. Would it bear the same relation to your work as the collections in the western galleries do to that of your colleagues?—That is so at present, as far as the Day Collection is concerned. I have the use of Day's collection, and so have my colleagues—it is transferable.

478. Supposing there was an improved Buckland Collection, with things like the Day section of it extended wider, would it be of importance to you?—Most certainly.

479. And would it be important to you to have it near you?—Well, I should prefer it near of course, and it certainly would be of great service to me.

480. And the neighbouring collection in the Natural History Museum would not be of so much use?—I use that a great deal, but that is essentially a preserved collection for reference. In this museum there would be running water and hatcheries, and it would be a thing I should welcome.

481. The difficulty with the British Museum collections is that you cannot borrow them?—Yes, that is so, but I have always received the greatest courtesy and consideration from the museum staff.

482. Supposing the collection was reconstructed as partly a technical one containing things like fish-passes and nets, and partly a zoological one of fish, would you limit it to British fish having regard to the neighbourhood of the British Museum, which is wider?—I think I should, because the British Museum takes in the fishes of the world.

483. And for your educational purposes the British collection would be sufficient?—Certainly.

484. Then, looking at the other side of the collection, the exhibition side, would you recommend that if it was reconstructed the exhibition should go on what may be called the new lines of the Natural History Museum?—Something akin to that. I have recommended in my notes that if the stuffed fishes are to be of any use it would be necessary to remount them with appropriate backgrounds, as is done in the Booth Collection at Brighton, which was the prototype of these exhibits. And if anything is done towards educating the public mind in matters which concern the shore and the surface of the sea. I think we cannot do better than the magnificent series of exhibits recently in the Hamburg Museum, which are preparations of surface and shore organisms mounted as nearly as can be in the natural condition. Their educational value is enormous. They are well worthy of adoption.

485. That new system is that you should exhibit a few things with natural surroundings?—Yes.

486. Would you make this re-constructed museum apply to both fresh-water and sea-water fish?—I think so, certainly.

487. (*Chairman.*) Can you tell us if the Hamburg Museum is a Government institution?—Yes. The particular work to which I have referred was mostly done by a German named Michaelsen who is an authority on another subject, his reputation resting on the study of worms. They are perfectly wonderful.

488. (*Mr. Spring-Rice.*) We have been talking about the use of an exhibition for research and education?—Yes.

489. Can those two be worked together?—In this case they could if there were hatcheries and properly constructed tanks.

490. So as to be useful for both?—Yes, that could be done if the tanks and the apparatus for fish culture were adequate.

491. To that end it would be necessary that the collection should be under the control, or closely connected with, the College of Science?—That would be a matter of convenience.

492. In the same way as the other collections of the Victoria and Albert Museum?—If the collection were collated at South Kensington, apart from the purely official supervision, we of the College of Science are the only people who could deal with it. At present the whole of the administrative affairs are conducted entirely by the officers of the Board of Education, and we have nothing whatever to do with them.

493. But you know as to the relation between the professors and the collections?—Yes. The custom has dropped lately, but in Sir Cuthbert Owen's time we used to have a Standing Committee, which was made up of certain members of the college who were consulted by the keepers of the museum as to the purchase of scientific apparatus. I served on that Committee for some years, but the Committee has apparently dropped out of existence. The keepers of the museum used to submit to us schemes and specifications and price-lists of things in the scientific way, which they thought of purchasing, and they would purchase them subject to our recommendation. But that appears to have ceased to be under the new administration.

494. Are you in favour of some such suggestion now?—Yes, decidedly. I think that the Board of Education now have an advisory committee or a body of experts who are called in consultation. I rather think so. I know on the art side a little while ago I saw a meeting of the kind going on.

495. (*Professor Herdman.*) Technical instruction has been mentioned in connection with this museum?—Yes.

496. Do you think any part of it could be used for the fishermen?—There is a difficulty in getting the fishermen to look at it.

497. Would it be possible if it were in London to make use of it in that way?—I suppose the nearest sea-fishery is on the Essex coast, and the Essex fishermen are few in number.

498. It would have to be taken to a fisheries centre, would it not?—Yes, I should like to see one in London and one in some fishery centre elsewhere.

499. Do you think it would be of any value in such a place as Grimsby?—I do, most certainly. You mean apart from the work being done by the various County Councils?

500. Or as a part of them?—Certainly I do.

501. Then you mentioned Plymouth as a possible scientific central office. Do you not think that Plymouth is very inaccessible?—I object in every respect to the locality, but my feeling is that as the building is there, and is a capacious, substantial building we must make the best of it. If I had anything to do with it I should not select Plymouth as the place for a central establishment, but the fact is that the building exists, and I think if the Plymouth staff were given

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a fleet of boats, under which conditions their work could be practically done at a distance, that would do a great deal to meet the present difficulty.

502. When you talk of a central office or bureau, do you mean for scientific research in connection with the fisheries?—I mean that mainly. My notion is that the Board of Trade officials should do the purely administrative work, and that if they had the scientific adviser, that he should be chief, to the extent that he should organise and systematise the work which is done at all the outlying establishments.

503. But should not the centre of scientific work be in London along with the administrative work?—It depends upon what you mean by scientific work—the actual manipulative work would be done at sea. But the work upon which the foundation of any generalisation or anything which may concern our behaviour at the sea would rest, would surely be done at the coast, as well as in the boats at sea, and in the laboratories on shore.

504. Have you considered that Plymouth is far away from the important fisheries?—That is the initial blemish; if it were possible to have the Plymouth building transferred elsewhere—it was a great mistake to put it there.

505. Then you spoke of the museum, or part of it, being possibly useful to you at South Kensington?—I think it would.

506. In that case it would have nothing to do either with the Department of the Board of Trade nor with the Department of Fisheries Research?—I should have thought that the Board of Trade would have exercised control over it in any case.

507. At South Kensington?—Yes, I do not see why the Board of Education alone should, simply because it is at South Kensington.

508. Do you think that it would be of use to the Royal College of Science?—I certainly do.

509. And also be connected with the Central Fisheries Office?—I think so.

510. Is this a new museum or is it the Buckland Museum?—Certainly not the Buckland.

511. Then we were talking of the establishment of a new museum?—Yes.

Professor RAY LANKESTER, F.R.S., called; and Examined.

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512. (*Chairman.*) You are a Fellow of the Royal Society?—Yes.

513. And Director of the Natural History Departments of the British Museum?—Yes.

514. Have you seen the reference to this Committee?—Yes, I saw the reference owing to its being sent to the Marine Biological Association of the United Kingdom, of which I am the President.

515. The object of our inquiry is to ascertain how far and in what manner the State could usefully take part in or assist the work of scientific and practical investigations into our fisheries?—The matter was brought before the Council of the Association at a meeting specially called for the purpose; they had had some time to consider it, and I may say that naturally they have always had this question in view, and been aware of the possibility of the State doing more than has hitherto been done in regard to ichthyological research, at this meeting on October 9 they passed some resolutions with reference to the terms of the letter from the Committee which they had received, and they asked me to present these resolutions to the Committee, and to explain or expand them in the sense which they desired. The Council, I should say, consists of a body chiefly of scientific men; it includes representatives of the Fishmongers' Company, representatives of the Universities of Oxford and Cambridge and the British Association, and various elected naturalists, several of whom are fellows of the Royal Society.

516. And they carry on observations in the Marine Observatory at Plymouth?—The Association founded a laboratory at Plymouth some years ago, and has made use of it ever since—I think about fifteen years now—for the purpose of observations upon the natural history of fishes and other marine animals, with a special view to the improvement of our knowledge with regard to fishes, in the hope and in the belief that that would result in an improvement or in valuable aid to the great industries connected with the fisheries.

517. Have they any definite scheme in their mind?—If you would allow me I would state what is the first of those resolutions they passed as expressing their view. I may say that the question which occupied their attention was a point which is raised in the reference as to whether a local or State central authority would be the more appropriate body to do more in regard to gaining a knowledge of fishes for the purpose of the fishing industry; and the conclusion that the Council unanimously adopted is this: "That in the opinion of this Council scientific research as applied to fisheries can only be adequately carried on by a central scientific staff organising and directing such researches throughout the United Kingdom." That point of view had reference to enquiries with regard to the great fisheries of the high seas, and the Council is perfectly well aware that a great deal can be done by local bodies with regard to local and in-shore fisheries.

518. Excuse me. Do you mean in the way of observations or of artificial reproduction and hatcheries?—I mean in the way of control. For instance, such matters as oyster beds, mussel scalps, the fishing for in-shore fish within three miles of the coast, conditions which may disturb or favour the abundance of fish within such limits—those are matters which a local body can deal with. But it has been found, I believe, everywhere in connection with this matter of fisheries that local bodies cannot deal with the fisheries of the high seas, and even those which are at no great distance from the shore cannot be dealt with by a local body. They can never be investigated nor controlled satisfactorily by local bodies. It was this fact which lead to the formation of the United States Fishery Commission, because the States, although the States have each their own Fishery Commission, could not deal with matters which were common to one State and another State. And so with regard to European fisheries. For instance, if we supposed that Grimsby were willing to attempt to deal with questions of North Sea fishery, and had the money, even the services of men to undertake it, the North Sea fishery does not really concern only Grimsby. The North Sea fishery is a matter which affects a great many towns, a great many interests both in England and Scotland, and on the Continent, and in any investigation undertaken by Grimsby it would be almost too much to expect that Grimsby should carry out the large and expensive and continuous investigations which are necessary for the benefit of the rest of the fishing world of North Europe. Again, a great point in the matter to which I have just alluded is that fishermen who frequent fisheries on various parts of our coasts, the great fisheries, are not local fishermen. The Lowestoft fishermen went down—they always do, and made their presence felt in Cornwall not long ago by fishing on the Sunday, and excited the enmity of other fishermen. The Scotch fishermen go to the Irish fisheries, and so on. Sea fisheries are in no sense a local interest, and have no local importance. A harbour may have a local importance, and the admission of fishing boats to the harbour may be a matter of importance to the town to which that harbour pertains, but the fisheries are not the possession of the locality facing the sea. And it therefore is wrong in principle and hopeless to expect that a town or a land locality will do anything serious or can do anything serious in studying or controlling the sea fisheries; it must be done by the State for the good of the whole community. That is the view which is held very strongly by the Council of the Marine Biological Association, and that is why they wish to see a central scientific staff organising and directing scientific researches through the country. They are not opposed to local arrangements, sub-divisions of any such staff—a Scotch, an Irish, an English organisation all under one central body. It has been clear to our Marine Biological Association for many years that a great deal is lost, and there is a great deal of superfluous work, and a great deal of want of organisation and co-ordination through the existence of various local bodies. The Scotch Fishery Board has, of course, important mercantile trade functions which are not in question, but the scientific investigations carried on by the Scotch Fishery Board would be more valuable if

they were carried on, so to speak, for the whole of the British Isles. That is to say, if they took cognisance of other areas than those immediately adjacent to the Scotch coast. Scotch fishermen do not confine themselves to the Scotch Coast. In the same way, with regard to the Irish Fishery Board, what they do for Irish fisheries is really not done for Irish fishermen but for the Scotch and East Coast fishermen, who go round there and avail themselves of it. With regard to their actual work—that is the point I was on—it is certain that these various authorities ought to compare their work. You want to study the movements of fish over a larger area than that of the Scotch and Irish coast. You want to include the English coast and to compare the facts ascertained in Ireland with those observed elsewhere to check them, and get important conclusions by simultaneously carrying on observations on the Scotch coast and other parts, including the Channel. All this can only be done by the action of a central body.

519. That would become, in your opinion, even more apparent if any international action were taken such as recommended by the Conference at Christiania?—Certainly, that would emphasise very much what I am saying. A much less valuable contribution could be made to the work of such study as is proposed by that Congress by a single Scotch or Irish or English Board than by a Board which represented the whole of the British waters and the whole of the fishing grounds to which English fishermen have access

520. Of course, any such scheme would include provision for local laboratories?—Yes, so far as laboratories are needful. I think one ought to be rather careful about any suggestion that expensive laboratories are a necessity in this matter. There are one or two good laboratories existing which can be used, and any investigation which is being carried on by such a Board would probably be carried on by means of a vessel, a ship, and some small hired buildings on shore.

521. You referred to the system in the United States. That includes, does it not, a large provision for hatcheries and also for a central museum?—Yes, I think the central museum is a very important element. The hatcheries—the question as to whether it is desirable to set up a hatchery of a particular kind of fish at a particular place must be determined by the study of that fish in its habits. The real success, so far as we know, of the United States Commission in that matter is, I should say, although I am open to correction by later knowledge than perhaps I possess, the hatching of the shad. I do not think that there are any definite results of value later than that, although very interesting experiments have been made.

522. They succeeded, did they not, in establishing the shad on the Pacific Coast?—Yes; but the great thing was increasing a supply of shad in its own estuaries which it frequents. I do not know that any naturalist would be prepared to hatch in the same way at once in England from what we know of fish.

523. I can suggest one to you—the smelt?—Well, it is not a very valuable fish.

524. Are you aware of the average price per pound?—Yes, but it is not a fish which would be largely consumed if more abundant. At the same time, I have no wish to deprecate that kind of work. It seems to me it is not really the most important thing which such a central body would have in view. It is rather the knowledge of the great sea fisheries and of the movements of fish and of how to prevent the destruction caused by fishing, and so on, how to prevent overfishing and disturbance of that kind. That is the main object which such a body would have in view.

525. That is far from being the exclusive object of the American Fishery Commission, is it not?—Yes.

526. Judging from their reports, they do very largely undertake to replenish the fisheries?—Yes, they attempt that, and, as you say, they have carried the fish from one side of the continent to the other, and they have made very interesting experiments in that way. If I may be allowed to say this, the second resolution which the Council asked me to submit is that, so far as they can judge, they would suggest as an analogy for a central scientific board the original organisation of the Geological Survey of the United Kingdom. I may say that analogy really was suggested many years ago, at the time of the Fisheries Exhibition, by the late Professor Huxley, who pointed out that, whilst a great deal had been done at Government expense for getting a sound knowledge of the mineral wealth of the country, yet this great source of wealth, the sea, had not been touched or approached in the same spirit or the same manner. The Geological Survey of the United Kingdom was originally a central body, with a local subordinate body in Scotland and Ireland. I believe the organisation is now modified. Of course, its great work has been done, and it has been a very great and valuable institution. It has turned out a splendid piece of work in the geological survey of the United Kingdom.

527. You spoke of the value of a central museum. Is there anything at the present time that would form a nucleus or model of such a museum?—In my opinion there is nothing which would serve as a nucleus: I venture to suppose that you may be thinking of the Buckland Museum. I have carefully examined that museum, and I do not think that there are half-a-dozen objects in it which would be of any value to any scientific body studying fisheries.

528. How about its aspect from the industrial point of view?—Nor there. There are a number of casts of fishes which are very roughly made, still more roughly painted, and which give a false and erroneous view or conception of the creatures which they are intended to represent. There are a few nets, and a certain number of oysters. The whole thing is not worth preserving in any form. That is the simple fact.

529. A collection made by the late Dr. Day has been mentioned?—That again was a very admirable collection of British fish which Dr. Day put together from his own collection, and other sources, for the great Fisheries Exhibition and was exhibited there. It is now very nearly worthless. It has been exposed to a full glare of light, so that every fish in the collection is as white as this piece of paper. It never contained anything very remarkable in the way of fish. There may be one or two specimens in it worth preserving

530. It was a complete series, or nearly so?—Yes, excluding some of the very rare fish. They have not been taken care of in the way spirit specimens ought to be taken care of. They have all got bleached and soft.

531. They have been used for exhibition principally?—Yes.

532. And the primary object of a museum, I take it, is not exhibition?—That is a most important question, one which I am very full of at the present moment, viz., as to what is the purpose of a museum. I think there are three purposes of a museum, and the most important is the one you are alluding to, namely, to get specimens to be studied and to be used by experts, by really serious students. We may call that "Record." That is the chief business of a great museum. Then there is of course, the edification of the public, the exhibiting to them that which will attract and stir up their interest in the matter. For that purpose you do not want to put out your rare and valuable specimens preserved in spirit, but important and striking things. Then there is a third purpose with which a museum may be concerned—with which as a rule a public museum ought to have nothing whatever to do—and that is what may be called academic instruction. It is the business of the museum of a college or a school or a university; its purpose is to enable a student to get up minute details and to take a minute survey in connection with text books. The third resolution of the Council of the Marine Biological Association is one of some importance, I think. They say "in their opinion the work performed by the central and subordinate bodies of such a central institution should include the collection of statistics, but no interference with the present statistical work of the Board of Trade is contemplated." There is always a considerable difficulty—there has been—on this subject of statistics. The Fisheries Department of the Board of Trade has statistics which are valuable from the point of view of railway traffic, and the frequentation of harbours, and so on, but do not give any information bearing upon fisheries really—they only give you the information that so much fish is landed at such and such a port. From the mode in which they are collected and the circumstances these statistics do not tell you where the fish came from. No doubt they have their importance, and are quite admirably collected. I am not criticising them for the moment, but they are not statistics which the students of fisheries want, and such statistics as I am speaking of I think can only be devised, set forth, and properly collected by a scientific body. We want statistics as to the number of fish taken on a particular

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point, at particular times, and we want to get information from fishermen when landing their fish as to where they have taken their fish.

533. Are you likely to get that?—It is a difficult matter, but no doubt it can be overcome. To aim at that, to attach sufficient importance to that, to get it done at all, you must not allow the matter to fall into the hands of the same body which merely collects trade statistics. That body will not be likely to treat it sufficiently seriously nor from the right point of view; on the other hand it would be a large and important part of the work of such a board or survey as I am supposing, and a very important part. At the present moment we are rather put off this question of statistics by the statement, and by the apparent fact, that the Board of Trade collects statistics of fisheries. I mean that there is a statistical section of the Fisheries Department, whilst really it is not the case that such statistics are collected—it is illusive; there are no statistics about fisheries collected by the Board of Trade.

534. I daresay you are aware that the Scottish Fishery Board has been undertaking systematic statistical inquiries?—Yes. Of course the Marine Biological Association is acquainted with that; and I know the valuable work done by the Scientific Department of the Scottish Fisheries Board. We should like to see that kind of thing extended and made continuous, so to speak, for the whole United Kingdom. There really is no reason why, with all respect and regard to Scotch fish, herrings, and salmon, and other kinds, why they should have the only active scientific investigation under Government aid in fisheries, or why any operations of the kind should be confined to a Scotch area. There is every reason why it should be expanded so as to include the whole of the British Islands. (*The witness here handed in a copy of the resolutions which he had read.*)

535. There is no utility, either from an economical or from an instructive point of view, in the existing collection in the Buckland Museum, you say?—That is my decided opinion, after careful examination of it, and with every regard and sympathy for the late Mr. Frank Buckland, a most charming naturalist and interesting man—but the things are really of no use.

536. To what extent have you considered the State under an obligation to maintain it?—That I must leave to the officials concerned to deal with.

537. I do not know whether your official position precluded you from signing the memorial to the President of the Council on the subject of the Buckland Museum last year, but at all events your signature is not there?—I know Mr. Bompas very well. I have talked to him about it. I have tried to explain to him in as unhurting a way as possible what I thought about the matter; I could not sign the memorial. It was not on account of my official position; I do not think that would have necessarily prevented me.

538. (*Mr. Crawford*) Do you happen to know what the constitution of the American Commission is?—I am sorry to say no, I do not at this moment. It was originally one Commissioner, and I think it is still a single Commissioner, with an annual grant from Congress, and reporting to Congress. The grant is very large. All the Commissioner has to do is to keep Congress sufficiently interested in his work to carry on the grant.

539. Is he personally a scientific man?—He was. The present Commissioner is not, and there was some trouble about it, which I cannot remember, but he is a good public servant—I mean a well-meaning man. There was an outcry about his appointment, and it was put right by his having an assistant or a sub-commissioner, who was a scientific man. Professor Baird was formerly the Commissioner, and an eminent scientific man; the present Commissioner is not a scientific man, but when there was some trouble in consequence of that, some appeal to the President, he took it quite fairly, and agreed to appoint a scientific man practically to act for him.

540. Do you know whether he is responsible to any particular department of the Government?—I know that he is not; he is responsible to Congress only; he is not responsible to any department.

541. Do you know how many vessels they have for scientific investigation?—I do not know how many. I know they have at least two.

542. Of course they have an enormous seaboard. I would like to put a question or two about the statistics. I understood you to say that it would not be a convenient thing for the Board of Trade, who collect statistics for trade purposes to be the body that was collecting those scientific statistics?—Yes.

543. But just as the Geological Survey is under the Board of Education, supposing you got your scientific organisation, would it not be under some department, probably the Board of Trade?—I should think it would be probably under some department. I should think the most convenient would be the Board of Agriculture.

544. The harvest of the sea?—They are associated in other countries, and even in Ireland that is so. They both of them want to bring a lot of scientific information into practical shape.

545. Is there not a little practical difficulty there? Many people have the experience that it is extremely difficult to get statistics—people object to the trouble of giving them?—Yes.

546. To a large extent the statistics that would be wanted by the Board of Trade at present, and by the new Board, would come from the same persons, and would it not be onerous to make a separate return?—It seems to me that that is a matter of considerable detail in the administration, but that it ought to be arranged. Supposing this Fishery Board existed, which I spoke of just now, it might be arranged with the officials of the Board of Trade that certain questions should be asked at the same time as the questions formulated by the Board of Trade; but it would be the business of the Fishery Board to see that these questions were asked, and if they did not get answers from officers of the Board of Trade, to get additional officers appointed, and so on. In fact, they would hold tight to their purpose of getting the returns and they would not be put off by the difficulty. They would have to get it for the essence of their work, and they would use all reasonable methods.

547. Then, with regard to having one central authority, and not having separate authorities in England and Ireland. I do not know whether you would recognise, whether it is quite a fair question to ask you, on what I may call practical or political considerations, but when you have got an organisation in existence in Ireland, and one in Scotland, do you not think there might be serious objection to taking away the powers that they have in that respect?—I should have thought that they could be amalgamated; they are not very large; it is not a very large interest at stake with regard to the scientific investigations. I mean, for instance, the Scottish Fishery Board has quite enough to do without undertaking scientific investigations. It has got a great deal of work connected with the branding of herrings, and so on, apart from that. The amount of interest involved is not very great in either case.

548. If I may take the case of Ireland, which is farther off, do you not think it might be undesirable to withdraw the interest in the sea fisheries, and the duty of collecting information about them, and making investigations, even from what I may call a political point of view? Do you think it would be desirable to transfer the centre of gravity to London for the Irish part, if it could be done efficiently where it is?—I am not an authority on political matters. I think it would be more efficiently done in London, and I do not see why a body having a seat in Dublin should investigate fisheries in the Atlantic or the Irish Channel, which are really not fished by Irish fishermen. That is the most important point that ought to be realised, that these fisheries seem to be what they are not, namely, local. In reality they are national. The Irish fishermen are few in number, and are not amongst the great fishermen. They have not got great fleets to go out to the deep waters; they do this only to a very small extent, and these fisheries are not fished by them. Why should money expended in Ireland be used for that investigation? It does not benefit the population of Ireland, although it may contribute in some way to the glory of Dublin.

549. You do not think that the object would be equally well accomplished by decentralising the work, at all events to the extent of the three kingdoms, and letting them compare notes?—No, I think myself that that would be fatal. You would not get any further. They would not compare notes, and it is not a question of comparing notes. We want certain questions to be investigated all round the coast: many things at the same time and the same moment, so as to give simul-

taneous observations. The questions to be pursued must be proposed by the central authority, and that central authority must see that they are carried out. There is a great deal of mere dilettante observation about fisheries going on. So-called researches are likely to be carried on, and look very wise and gain popular approval, and the ordinary political administrator would not be able to criticise them. He may be taken in for years by that kind of thing. What we need is a reliable central authority to see that this kind of work is tending to some definite end, and has a meaning, and we can only have that by having a central authority conducting practical operations in different parts of the kingdom

550. (*Mr. Pelham.*) You spoke about the Board of Trade statistics; are you acquainted with the way in which those statistics are collected?—Yes, to some extent. I remember going into that some few years ago.

551. That system being a number of perhaps 150 to 170 local collectors. Would not that be the best way of obtaining the statistics if it was improved?—I think that it is extremely probable that in certain places those same people might be employed by the Scientific Board. They might, with the assent of the Board of Trade, have additional work, and some additional pay possibly given to them But it would not follow that they would always be distributed precisely in the localities and places which the Scientific Board wished.

552. You would attach considerable importance I suppose to valuable statistics in places like Grimsby and Hull?—Yes.

553. You would want the trade statistics?—Of course these would be always valuable.

554. You would not suggest instead of the trade statistics that you should merely take the returns made by scientific explorers?—Certainly not. The trade statistics have their own definite significance and value as they stand.

555. I suppose that you know that the statistics of the Board of Trade are compiled by experienced statisticians in the Statistical Department?—Yes.

556. I do not know whether you know that the whole matter has been under the consideration of a Committee like this within the last twelve months?—No, I was not aware of it.

557. Does it want a very scientific expert to be able to collect those statistics as to the location of fish where they are taken?—Yes, I think it does. It wants someone who is directly aiming at certain results who has a particular theory which he wishes to test.

558. Is it not rather dangerous for a man to have a particular object in view in collecting statistics?—Not if he is a scientific man; he has never a personal object in view. It is true that he always has an object in view; he has always a hypothesis, and it is his object to see whether it is true or false. It is not a matter of interest to him to prove that it is one rather than the other—he merely wants to get so much further.

559 But be is rather apt to be governed by the particular view which he has taken—a presumption, is he not?—No; that is a complete misconception of the scientific method.

560. Should not the collection of trade statistics be rather separated from the particular expert?—I think the collection of trade statistics, as the Council of the Association expressly stated, should be separated and left to the Board of Trade, but that scientific statistics for a scientific purpose should be collected under the immediate direction of the new Scientific Survey.

561. I am rather suggesting that the scientific experts would require the trade statistics as to which to work?—I think that is not the case. We have not found them to be of any use hitherto, because they merely represent the landing of so much fish at such and such a port, and even when they go further than that they only represent the nationality of the bottom in which the fish are landed, but the sources of the fish and the particular times at which they are caught is not given.

562. You said just now that you were aware that in Scotland they had obtained particulars as to the grounds where the fish had come from?—Yes.

563. But you are aware that these are obtained through the collectors of the trading statistics?—Yes, by means of the scientific department of the Scottish Fishery Board.

564. You have not told us what investigations this central body should undertake?—No.

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565. Can you suggest what they should undertake?—Of course, I suppose that in this reference the Committee are aware of the proceedings of the Christiania Congress, and of the scientific investigations which have been undertaken by the Scottish Fishery Board, and the Irish Fishery Board, and by the Marine Biological Associations. Those are the researches which I think should be carried on under the auspices of the central body. I am not prepared at the moment, but I should be pleased to submit a memorandum if you wish it, giving some kind of epitome, or to get Mr. Allen to do so, of all the researches which have been made during the last fifteen years. They are chiefly with regard to the movements and breeding of sea-fish.

566. As regards the movement and breeding of sea-fish, would you obtain that mostly from vessels fitted out for the purpose, or through the trading vessels?—Both. I think the fishing vessels could be used to a considerable extent excepting for the discomfort of any investigator who should accompany them.

567. It would not be possible to make use of skipper and crew to any extent to collect?—Only to the very smallest extent under the present circumstances

568. To induce him to tell where his fish had been caught, or to say whether the fish were big or small?—Yes.

569. You have not thought what equipment would be necessary to carry out the investigations recommended by the Christiania Conference?—No, I have not thought of the details of that, but I imagine the kind of thing which we were thinking of, or have thought of, at the Marine Biological Association would involve the possession of two first-class sea-going ships, trawlers I mean, that could stand any weather in the North Sea, and be thoroughly well-equipped, vessels costing several thousand pounds, £10,000 to £15,000 apiece, and costing £700 or £800 a year to keep up.

570. That is two vessels for the United Kingdom?—I say at least two, but, of course, with a larger scale of operations more would be needed. If it were larger we should want a larger equipment. You want an office in London and a museum. You want funds for temporary laboratories on shore at the one that spot, and I should hope that such an institution would use to some extent the existing laboratories, for instance, the laboratory at Plymouth. This laboratory receives a grant from the Government, the condition of which is stated by the Government as follows, viz.:—That space shall always be afforded in the Plymouth laboratory for the investigations of any State-recognised authority. That was the condition on which we originally received a grant, and up to the present moment the State-recognised authority has not come forward to ask for the use of this space, but we shall always be glad when he does.

571. That is only space?—Yes.

572. It does not suggest that you should put the staff at the disposal of the Government?—No, that is the point. We have always hoped and supposed as possible that the Government might, so to speak, provide one or two additional members of the staff who would be Government officers, and work there as many months in the year as they wished.

573. But to go back to the scientific investigation of the sea, I suppose a great part of the scientific part of the work would be done on shore?—No doubt a considerable amount of the work would be done on shore, but the staff would also be collecting and making notes of all kinds at sea.

574. Would your chemist or biologist have to go to sea?—Very often, no doubt.

575. But not necessarily always?—No.

576. If they directed the mode of collecting specimens they could leave it to someone else?—There would be younger students on board for the time; there would always be a scientific man on board to see that things were done properly. But the great part of the work would be carried on on land in examining the materials brought to shore.

577. (*Mr. Green.*) I think you said that the central body would do instead of local scientific bodies, such as those of England, Ireland, and Scotland separately, the central body would do all that was necessary?—The idea is that you would have a central body, with local centres under it. Just in the same way as the Survey

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originally was a central office in London. There was a Director-General of the Survey, with local directors and staff in Ireland and in Scotland.

578. Do you think that the local information, take for instance what the Scotch administrative body would require, could be got as easily by applying to the central body for it as to their own scientific advisers at hand to advise on local things?—I think it could be got better. I think that it would avoid a narrow and local point of view about such matters. The man would get the general experience of other localities in similar conditions.

579. Do you think if the local bodies were to instruct the Fishery Boards under the Board of Trade, the Scottish Fishery Board and the Irish Board, which is the Department of Agriculture—if these three bodies were organised so as to meet annually or three times or four times a year, and discuss general principles with regard to the observations they considered desirable, that all the objects aimed at would be obtained in that way?—No, I do not. I think that for these local boards to deal with a question that is not local is a mistake. That is what I am endeavouring to point out. Of course we have great respect for all the researches about the Irish seas and the fisheries there carried out by the Dublin board, but it is not a local question at all; it does not concern Ireland, although Ireland is paying for it. It is a question of Imperial importance: it is of importance to the United Kingdom, and the information which you get in the Atlantic off the coast of Ireland applies to the coast of Scotland, and many of the facts which you get are important in relation to the North Sea and to the Channel. We do not want this separate treatment of a common interest; it is a wasteful and difficult way of proceeding.

580. What we think is that what is directly investigated on the spot is of local interest and of local importance?—But it is not on the spot, if you will excuse me. The investigation twenty miles away in the Atlantic is not on the spot.

581. But it is on the spot of the local fishery. We have in Ireland a number of deep-sea fishing boats, but the Irish large boats taking part in the Irish fisheries are more numerous than all the visitors together, whether they come from the Isle of Man, Scotland, or France, or anywhere else. So it is of great local importance to have the knowledge by the scientific staff working locally. But I quite see that there are a number of questions which might be dealt with, as you say, by a general investigation, but the great majority of the questions are essentially local?—I do not agree with you. What are the questions which are local, and which are not of a general character? I do not know what they are.

582. Would not you think that the time of migration of flat fish on the various grounds was local?—No, because the conditions which affect that are conditions which affect flat fishes elsewhere. That is a question of the general habits of flat fish and their migration, and what we find out in one part of the sea area applies to another, and gives information and suggestions with regard to another.

583. Do you not think that the conditions are so different on account of the proximity of a deep ocean off Ireland that the observations in the North Sea are of very little assistance in studying the movements of similar fish?—That we shall not find out until the two places are investigated by one body, and then we shall know whether it is the case or not.

584. Dr. Fulton was telling us of a new class of statistics which he has adopted, that is statistics from the steam trawlers, statistics of their catches, and of the places where the fish are caught, and he seems to be very successful in getting them. Does not that show that trade and scientific statistics must go hand in hand—you cannot separate them?—I do not think that Dr. Fulton does represent trade in insisting upon these statistics. The trade people have had the means of getting them for any number of years, and have not taken them. Of course it is not necessary to have a new class of officers or new individuals to furnish us with information in answer to scientific questions. The thing is to *ask* the right questions of the people who exist. I have myself—treating this as a general question—thought that the Board of Trade is not a body to carry on scientific investigations. They have other objects in view. The scientific object is crushed by the far more voluminous and obviously important trade statistics.

585. (*Mr. Spring-Rice.*) You spoke a little while ago about a central museum that you would recommend. I should like to ask you if you could describe in a general way what sort of a museum it would be?—I think I have seen such a museum in Norway; it is a museum containing the fish which are fished for, and the food, and the nets, and it exhibits maps also, and all other matters relative to the fisheries. Such things, a certain number of them, are exhibited to the public, but still more are kept for the purposes of the survey; large collections of the "Plankton"—the floating food taken from different places, and always probably in the course of study and comparison by officers of the Survey. The mackerel of Ireland and the mackerel of the Channel was a matter we were investigating lately, as you are aware, at the Plymouth laboratory. That was done by study of museum specimens, and it is for such work that a central museum would be chiefly valuable.

586. That would be a museum unlike the corresponding part of the British Museum?—Quite.

587. Taking your three heads for the uses of a museum here, you would intend it to be partly for edification. You would exhibit a selection of things in a way to take the public eye and attract interest?—Yes.

588. In your description in a previous answer you suggest that the main purpose of a museum, apart from what was excepted, would be in the nature of a record?—Yes.

589. In that sense it would be parallel?—A record for a special purpose.

590. Yes, it would be a specialised national museum rather than an academic museum?—Yes, certainly.

591. Of course, you would attach it to the central body to be formed under your scheme?—Yes, it would form part of the central office.

592. And be managed for this purpose?—Yes.

593. On the understanding that it should be both for the public and for research?—Yes.

594. You probably would agree that for the purposes of the public the exhibit part of the collections would be comparatively small?—Yes.

595. You would not attach it to any educational institute?—No, certainly not.

596. Though it would be of educational value?—It would not be of educational value in the vulgar sense of "school" or "academic" education.

597. You spoke about using a shore laboratory. Of course the Plymouth Laboratory is specially designed for work of this nature, and would be no doubt the most useful for anything that came in in its vicinity?—Yes.

598. Taking the coasts of the United Kingdom, do you contemplate the necessity of erecting any special laboratories to speak of anywhere else?—Frankly, I do not. I think with properly built and properly-sized ships at the disposal of these investigators, and with temporary buildings, temporary shade, and hired buildings at the places where any interesting research was going forward, they would have all that is in any way needful to be supplied, and that it is not desirable to sink money in extensive permanent laboratories at particular spots.

599. Could you not utilise the organisation of some, at all events, of the universities and university colleges?—To a certain extent you might do that, but it ought not to be possible, because those universities and university colleges ought to be using their own laboratories, and there ought not to be room for this addition.

600. But would not some of the purely scientific study of the life history of some special animal be doubly useful, useful for practical fishery purposes, and also to the scientific side of a university?—Perhaps, but I do not think you ought to call upon them. I do not think it desirable that the two objects should be allowed to interfere with one another. I mean that the work of a university teaching zoology ought not to be allowed to become specialised or forced into a purely mercantile line of enquiry.

601. As to the statistics, I gathered that you really mean that a central body and a scientific body ought to propound the questions and to discuss the answers?—Yes, and also to see that the answers are given and are pursued with sufficient determination and energy to see that if they cannot be got by one means they shall be

got by another, not to be put off by subordinates saying, "It is impossible to get this or to answer these questions, and it is a very difficult matter, and it would cost something." They ought to have it in their own hands, and see that it is done, and not to have someone else saying that it is very difficult to be done, and that they will see about it in ten years time.

602. You recognise the difficulty of having any duplicate local organisation?—Certainly, but the scientific survey could employ the same persons as the Trade Survey does; you probably would get the same men to collect answers to your questions. You could use the coastguard.

603. That is what is done now?—But I mean there are some still available.

604. We agree when speaking of statistics for this purpose that we mean a sort of statistics which are collected as statistics, not the results of observations conducted by an experimental ship?—Statistics collected as to the actual things passing through the fishermen's hands.

605. That must be collected at the ports?—Yes.

606. (*Professor Herdman.*) I suppose we may take it that you personally would recommend that Great Britain engaged in this international scheme of the Christiania Conference?—Yes.

607. You would recommend that?—Yes, that in the most general terms; the details are another matter.

608. Well, those are all the details we have before us?—Yes.

609. You see our position; these are all the details we have before us. Do you suggest that it would be advisable to take part in that investigation on what is before us?—I think that it is very desirable that Great Britain in an investigation of the North Sea should act in combination with other North Sea powers, but I think that we should be very careful in not letting ourselves in for a merely bureaucratic rather meaningless thing going on for years, and leading us goodness knows where.

610. May we take it that you do not give in your adhesion to the scheme in its present form?—I am not prepared to say that. Possibly it could be arranged with the proper people to work it by proper negotiations, but what I feel is that there is no body at present to do so. If we had the scientific body that I am speaking of, if we had a Scientific Fishery Board for the United Kingdom, it could deal with those people and with the whole of that proposition.

611. Our present position is that this country is asked by the Conference to join the other countries in this scheme, which they wish to start at once; would it be worth while postponing this?—I should say that it would be worth while postponing it if there was any intention on the part of the Government of getting a head adviser or of creating a body to deal with the matter.

612. I think it would help us if you would tell us in what respect such an international scheme would be better than a well thought out national scheme for the investigation of the British coast and the adjoining seas in the interests of British fisheries?—I am afraid I cannot go into details about it, because I did not suppose that that was part of what the Committee wanted to talk about. But, in a general way, I should say that international action is valuable, because you get people of different sets of ideas on this matter coming together, with different suggestions to make, and you get extremely valuable local information brought to bear on the whole question. I refer, for instance, to what Norway has done in this matter of sea fisheries. She has started a very considerable mine of originality, and has done excellent work.

613. (*Mr. Crawford.*) Have they got boards of the kind you suggest?—Yes, they have got a governing body. I do not exactly know its constitution.

614. (*Professor Herdman.*) You know this map which is in their scheme (*handing in the same.*) Can you tell us in regard to that area that is left for Great Britain whether those are lines along which observations are to be taken, or enclose areas which are to be investigated?—I cannot tell you. I am not prepared to go into that matter.

615. Does it not strike you in looking at it, that a very great part of the English coast is omitted—a great part of the British sea which it is most desirable to explore is not included there?—It does; they are focussing their ideas on the North Sea, and they have not sufficiently recognised that the Atlantic and the mouth of the Channel have got something to say to the North Sea. I quite agree with you, Professor Herdman, in your general view; I should much prefer to see public money expended on a complete survey of the British seas, say, the 100 fathom line all round the British coast, to money being expended on this international arrangement.

616. That is what I wished to get from you—your opinion with regard to that?—That I quite agree with; but I should not like the prospect of the one being made a reason for dropping the other. We have a certainty of the second thing.

617. You spoke of the two ships being required for British investigation. I suppose you are aware of a scheme, which is only in manuscript, of Mr. Garstang's submitted to the Royal Society?—I know that it is there.

618. He talks of one new vessel?—I do not think one vessel is sufficient—I consider that a minimum of two is necessary. You want to be carrying on simultaneous observations. One of the great points in such matters seems to me to be that you should not be confined to one area.

619. We have had it in evidence from other witnesses that something like a fleet of vessels would be required?—The more the better.

620. For the British part of that international programme I was wondering to what extent you agreed with Mr. Garstang?—I think that two first-rate vessels, and in addition smaller vessels which are inexpensive would be desirable.

621. Now, about a more general matter. You were talking of a central board; would you contemplate that such a board should have anything to do with the administration of the fisheries?—No.

622. You mean merely for scientific research?—Yes.

623. Then you see no difficulties in dissociating the scientific research altogether from the administrative?—No, I see no difficulties in that any more than in other similar cases. The Geological Survey and Mining Record Office have nothing to do with the administration of mines or the carriage of minerals by railways, nor has the Board of Agriculture to do with the farm labourers' union or the bringing of produce to market.

624. We have had the view that it is exceedingly helpful for the scientific and administrative work to go on together, but you do not agree?—What I think about it is this: the general conclusion which I have come to from observation during my life, is that when we put together the administrative and the scientific, the administrative simply crushes down the scientific. All the available money is spent on administration, and the science is starved. The only scientific institutions which are allowed to exist are those which, like the Geological Survey, have no administrative side. That has gone on because it has had no administrative work connected with it; and in the same way the Royal Gardens at Kew are allowed to go on. But if there were practical horticulture in one and actual control of mines and such works in connection with the other, these administrative activities would have eaten up all the salaries, and science would have ceased to have any support. Anybody who wants a post or a berth can, or is supposed to be able to, fill an administrative post, and so they are multiplied, and the salaries are used up for the purpose; whereas the scientific person cannot masquerade as such. He has to be a genuine scientific investigator or he gets found out and condemned. You cannot put an utterly incompetent person into a scientific post, and therefore the posts are gradually suppressed. When scientific work is entrusted to non-scientific officials and a non-scientific department it is invariably neglected, and the public money originally assigned to it is handed over to useless and ignorant clerks.

625. Then the third class of work associated with the fisheries is the technical instruction of fishermen. Would you contemplate that the scientific authority should take that over?—No.

626. That should be left to County Councils?—Yes.

627. You spoke of not necessarily having the chemist and biologist on board the vessels all the time. I suppose you realise that to take part in the scheme it would be necessary to do the hydrographic part?—Yes. At all events, there would be some scientific man in

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charge, a young man, but the important work would not necessarily be done always on board.

628. Of course the greater part of the work would have to be done in laboratories on shore. But what I mean is this, that it is perfectly clear from this programme that a chemist and a biologist must be all the time on board taking observations?—Of course the Director of Survey, and the assistant directors in different parts of the country, would not be on the ships: they would have scientific men on board the ships, just as the Geological Director has assistants who are about the country, and making their maps.

629. It has been suggested that a large amount of detailed information as to the condition of the fishing grounds at all seasons of the year is what we require. Do you think we can get that by taking part in this international scheme—a large amount of detailed information as to the condition of the fishing grounds, presumably the British fishing grounds at all seasons of the year?—Yes, I imagine that that would be one of the results of what they propose.

630. Do you think that we can get that required information best by taking part in this international scheme, or could we get it more easily or more fully in another way?—I did not come here to offer an opinion upon that international programme, and I am not prepared to answer this question. I understood that this committee was concerned with the question as to whether it is better to create a central body, or to confine to local bodies the doing of this work. But the particular scheme of the Congress I am not prepared to criticise.

631. I thought you realised that the scheme was before us?—No, I did not think it was, as your reference did not allude to it in any way.

632. (*Professor Thomson.*) Does not your analogy referring to the Geological Survey suggest very forcibly that there should be one man at the head of the whole scientific investigation?—Of course there are various ways of carrying out an organisation of that kind.

633. But you lay no stress upon the fact that there has been always one man at the head of the Geological Survey?—I suppose you must have a chief in any office of the kind, whatever he may be called.

634. Well, in Norway there are three. One scientific, two others not distinctively scientific?—It is not the sort of thing that I should aim at. That is a Commission rather than an office like the Geological Survey. It is not an institution with a number of employees with a central power of its own—it is more like a Commission.

635. I simply wished to know whether you meant to lay particular stress on this, that there should be one head, or not?—Yes, I should say so. One chief officer, and then you would have other officers, local officers, of course.

636. (*Mr. Pelham.*) You said something about the tendency of the administration to crush out scientific research. Would not there be a risk, if the scientific part was separated from the administrative, of the scientific part taking up work which was purely scientific and not practical?—No, because there is really no such thing; there is no scientific work which is not practical—all scientific work is practical. You cannot say this is not practical, I mean as long as it is on the subject in which you are interested.

637. Might there not be many subjects connected with fish which are immensely important and immensely interesting to the scientific man, but which would have no immediate effect on fisheries?—I do not think there are. I do not know of any such subjects. They must have an important bearing within measurable time upon fisheries. You cannot act, as you seem to think is possible, in endeavouring to apply science to practical purposes. You cannot say, "I want to know this but not that," you want the whole thing. There is no such thing as commercial chemistry—it is chemistry. There is no such thing as mercantile or "practical" research work with regard to fish. You must study the scientific history of fisheries—ichthyology; you cannot take only what is useful; you leave something behind if you do.

638. The present thing before us and before the Hydrographical Conference is the depopulation of the North Sea?—Yes.

639. If it were left in the hands of a scientific body to look into these questions generally might they not go into the life of some fish which was of no practical interest to fishermen—inedible fish, for instance?—That would have its bearing upon the edible fish. But take the analogy of the Geological Survey. That was started for the purpose of ascertaining the distribution of valuable mineral wealth of various kinds, but the surveyors did not proceed to restrict themselves to pointing out where gold or coal occurred. They made a complete geological study of England, and that is what has got to be done in regard to fisheries—you cannot pick out the precise things that you want and so save time. There is no royal road to sound knowledge.

640. What I meant was that I thought the money might be spent for many years on some question which could not possibly be solved in the immediate future, and more practical subjects connected with fisheries might be neglected?—I do not think myself there is danger of that. I think the danger is really the other way, that when people try to go by ready roads to get the knowledge which a practical man wants, they waste their time very often.

641. I was not suggesting that non-scientific men should take up the inquiries?—But if the direction of observation is limited by non-scientific men you will not get the real results that you want. In successful State-supported institutions for furnishing the Government and the country with true and sound knowledge, there has not been such limitation. Take the two instances, which are of great practical value; that is to say, the Geological Survey and the Royal Gardens at Kew. They are absolutely geological and botanical; they were never limited by the impatient and ignorant demands of administrative superiors; but they are of immense practical value. If they had been limited in the so-called "practical" point of view they would probably have been of very little use at all. You cannot tell what will be useful and what will not.

642. (*Mr. Crawford.*) One more question. With reference to the questions of Professor Herdman about the international scheme, I am not going to ask any questions about the scheme, but might there not be this advantage in international co-operation that we might get a proper basis for any legislation that might be required, interfering with and affecting the modes of fishing?—Yes.

643. And that such legislation taken by one country without the assent of the others might be inoperative, whereas joint co-operation would be useful?—I have no doubt that is a most important element in the international scheme.

THIRD DAY.

Thursday, 24th October, 1901.

PRESENT:

The Right Hon. Sir HERBERT MAXWELL, Bart., M.P. (*Chairman*).

WALTER E. ARCHER, Esq.
DONALD CRAWFORD, Esq.
The Rev. WILLIAM SPOTSWOOD GREEN.
Professor WILLIAM ABBOTT HERDMAN, F.R.S.
The Hon. THOMAS H. W. PELHAM.
STEPHEN E. SPRING-RICE, Esq., C.B.
Professor J. ARTHUR THOMSON.

R. E. MARTYR, Esq., *Secretary*.

Professor HERDMAN, a member of the Committee, called; he handed in the statement which he had been asked to prepare in regard to his scheme for the investigation of the Irish Sea, and after explaining some points on the chart, was Examined (*See* Appendix I.)

644. (*Mr. Pelham.*) In your scheme for the investigation of the Irish Sea, you divide the subject into two kinds of work, the systematic statistical work is the first. Would that include statistics taken with a view to show whether the supply of fish has increased or decreased?—The statistics such as I contemplate might lead us to acquire such knowledge. That is indicated at the very end, as the second of the aims I have in view; it is in the very last page at the bottom of the pamphlet.

645. What I meant was this: are you going to depend upon the observations of this steamer for forming an opinion as to whether the population of the sea increases or decreases?—No, I should supplement those scientific statistics by statistics obtained in the ordinary way from the ports, and if possible from all the boats fishing by some such scheme as Dr. Fulton has told us about.

646. You would depend to a certain extent upon the ordinary trade statistics?—Yes.

647. On your first day out, how much would you accomplish?—You mean on the trip? (*Pointing to map.*)

648. Yes?—Start from Fleetwood and steam across to *this* region of deep water; take three hauls, and go into Port St. Mary for the night.

649. What is the length of one trawl?—A couple of hours.

650. What distance would that be?—That would vary considerably according to the weather and the ground, and the other circumstances. Perhaps it would be useful if I added this remark, that I have gone over each day's work with our superintendent, who is practically captain of the vessel; he has a captain under him, but he knows all about the navigation and the work at sea, and he considers each of these day's work can be managed in the day.

651. What would be the breadth of the trawl?—You mean the size of beam?

652. Yes?—Probably an intermediate size between the one used at present on the "John Fell" and the commercial one, probably rather less than 50 feet.

653. Then you propose to go in a straight line as far as you can?—Yes, I do not consider there is any great importance in adhering to one particular line. I rather regard these places on the sea bottom as areas which have to be investigated. In fact, you could not, probably in most cases, hit exactly upon the line that you have taken on previous occasions.

654. If you go over this ground, say, in the month of March, you will not go over it again until April?—Quite so.

655. Will you try to hit off exactly the same ground?—Yes, ground at the same depth, and under the same conditions, but it need not be exactly the same line. May I take an example of that, because that is a general sort of question? For instance, you have here the Bahame Bank; one might trawl it sometimes in one direction and sometimes in another. It is rather an area rather than a line that I feel it desirable to investigate, a limited area, the conditions of which you know.

656. What are the principal fish in this Irish Sea?—We regard our sole fishery as very important indeed. Then there are the other flat fishes.

667. I was not doubting the value of these inquiries for your particular purposes, but thinking of it as applied generally to the North Sea, and it has been rather suggested by some witnesses, I think, that you could depend upon these monthly trawls for forming a guess as to the population of the sea, and as to the number of the fish of a particular kind. Do you think that that would be sufficient?—You mean without getting any trade statistics?

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658. Yes?—No, I think it very desirable to supplement these experimental hauls by all the other trade statistics you could get.

659. Would not the other statistics, if they could be made accurate, and have more money spent upon them, be the principal basis of any calculations as regards the amount and size of the fish?—I think that these experimental hauls would give you a good deal of other information which it is very desirable to have. For example, you know exactly the ground you were on, and its conditions.

660. I suppose it would vary often happen that a trawler might have been out on the ground before you?—Yes.

661. And the next time the trawler would not have been there for some weeks?—Yes.

662. And that might affect the result?—Certainly.

663. Do soles move much during the year?—Yes.

664. I suppose they move rather earlier in one year than in another year?—Yes.

666. If you had two trawls, taken by two boats at the same time, running alongside each other, would you expect the results to be pretty well the same?—Yes, I think there is a constancy in hauls on the same ground, if you take an average.

665. I quite agree, if you take an average; but it wants a large number in order to be able to make an average?—That is the question: How many it requires to make an average? It would be ideal to have six hauls on each occasion, but I think that is perhaps impracticable; we cannot hope for so many; I think two or three would give an average.

667. Supposing I was to walk from here to Charing Cross once a month on one day, and made a point of counting the people and the vehicles that I meet, should I be able, at the end of the year, to say whether the traffic had increased or decreased?—You go at the same time of day?

668. Yes?—It would.

669. Do you think that would be sufficient? I might go on the Lord Mayor's Show Day, and that would upset my calculations very much?—Yes, no doubt exceptional occurrences would vitiate your conclusion.

670. But when you take a trawl two or three miles along, there are certain parts where it catches nothing?—Well, it depends, you see, upon the ground very much.

671. That is my point?—But we have chosen certain grounds.

672. But you think that the fish will be scattered uniformly over that particular piece of ground?—Yes, on the average.

673. Yes, on the long average. I am going to take another example: a bit of land trawling. Supposing a poacher was to drag a net across a field in order to catch partridges once a month at night, would he be able to

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form an opinion as to the number of partridges on that particular land on the farm generally, as to whether they had increased or decreased?—He would be able to form a better opinion than if he did not do it—than if no observations had been taken at all.

674. Is it not your experience that the hauls which are taken by your trawler vary tremendously?—No. I have come to the conclusion lately, having been going over a thousand hauls taken in this area during the last eight or nine years, that on certain grounds there is a very great constancy in the results, so that, for example, on our Blackpool ground you can predict what you are likely to get at a particular time—of course, I do not say that you can predict exactly, but you can do so approximately. You know what the general haul will be, and what sort of numbers you are likely to get.

675. You have been telling us about experiments on certain banks, but on some days and weeks they would be in much deeper water, as marked dark on this map?—This darker colour and the blue patches, which are of a darker shade, show the deep channel running along the west side of the Isle of Man and Ireland with two extensions towards England, one at the north and the other at the south of the Isle of Man.

676. Would it not be possible that if one trawl was made in March in one year and another trawl made in March of the following year there would be, especially in deep waters far away from land, a considerable likelihood that it would not cover exactly the same ground—I think you admitted that?—I admitted that—not exactly the same ground.

677. But in this deep water, would it not be likely that the surface of the sea bottom varied considerably between here and there? (*Pointing.*)—No, you can always determine what bottom you are on by the lead.

678. But doesn't it follow that you come sometimes on different sorts of soil, first a stony bit and then a sandy bit?—Are there not variations of that nature?—There may be little bits, but I do not think that that affects the matter. You can rely on mud being where mud is marked pretty constantly this year and next year, and similarly with sand and certain calcareous deposits.

679. If you found so many soles in March, say a hundred soles in March, and five hundred in November, you would not assume from that that necessarily the supply of soles had increased?—No, there are a great many other things to be taken into consideration—the migration of the fish, and other circumstances. You have to take that mere numerical result into consideration along with all the other results.

680. But also you would rather wait till March came round again before you made any conclusion at all?—Yes.

681. I suggest that you would have to wait for a great many Marches before you get a sufficient general average?—I think that if this scheme were carried out with the appliances that I have suggested, not merely in the imperfect way that it has been done in the past, if a steamer were devoted solely to this purpose, and, better still, with an Irish steamer working also with us, at the end of five years we ought to be able to tell whether there would be definite results, or whether it was futile.

682. Then you would attach considerable importance to what I may call trade statistics if they could be made more accurate?—Yes.

683. I suppose one of the weak points of the present statistics is that you do not know where the catches have been made and you do not know the fishing power which has been used?—Quite so.

684. Do you think that something like what Dr. Fulton said was done at Aberdeen would be extremely useful?—I think it would.

685. Have you formed any idea as to whether trawlers in England would be willing to give particulars?—I am very much of the same opinion as Dr. Fulton with regard to that. I think that there is a certain amount of unwillingness, but that that can be largely got over by them recognising that the information will not be divulged to their fellows in the trade.

686. If a man has got a particularly good place he will try to keep it to himself?—Yes.

687. (*Mr. Crawford.*) With reference to one question Mr. Pelham asked you on page 1, you said, "I consider that what is necessary to give us that information is the nearest approximation we can make to a census of certain parts of our seas," I remember when you were examining a witness you used the word "census" as an appropriate word, which it certainly seems to be; but "census" implies that you are trying to arrive at the population of the sea?—Yes.

688. And comparing it one year with another?—I recognise that it is much too ambitious a word to use. I want a word which does not imply such a degree of exactitude. Still "census" serves its purpose—it reminds us of the aim.

689. (*Mr. Green.*) I approve of a great deal, and, in fact, most of what you have said, and I think that a number of points could be settled between us very easily as to details, such as the size of the trawl most suitable, and a whole lot of details of that sort, so that I will not ask you many questions about those things at all at present. I think what you say is quite right about this being an area of limited extent where the problem can be got at more definitely than in the North Sea. Do you think from your experience of this case that the soles which are taken in this area come from outside?—I am inclined to think that our soles do not leave this area. But here, again, if there is any new evidence brought up I might have to change that opinion. My statement is simply that I have not any evidence yet that they leave this area.

690. And I quite agree with you; I do not think that they do, but we have not sufficient evidence. That presents the problem in a very suitable form then for investigation, does it not?—Yes.

691. As an illustration of the way in which this thing could be conducted, the case of a man walking from here to the Strand and counting the vehicles was suggested. Do you not think that a more suitable way, would be to walk through a rabbit-warren at different seasons and count the rabbits on certain fixed days under the same meteorological conditions? You would be able to form some idea after a few observations whether the rabbits were increasing or decreasing in the rabbit-warren?—I think you would.

692. Would that not be a fairer illustration of what you are doing in fishery research than that of walking along the Strand?—I think it would.

693. The problem would be more similar?—Yes.

694. Have you formed any idea as to the migration of hake in this area?—No, we only get the hake down at the south end of that district that you have before you, so that we only just touch it.

695. To come to the big question now—how do you think that this problem can be best worked—by a central department, or three departments working in harmony?—You mean one for each kingdom? Do you mean central for England or for the United Kingdom.

696. Central for England, Ireland, and Scotland?—That has no particular bearing on my scheme.

697. (*Mr. Spring-Rice.*) You bring forward this scheme, not for the special benefit of the Lancashire district, but as a general method of getting information which would be generally useful for all the fisheries of the United Kingdom, do you not?—That is so. It is not in the least in the interests of the Lancashire sea fisheries district. In fact, a considerable part of the area that I should like to see investigated is outside that district altogether. I chose this ground because I think it is the most suitable ground in the seas round the British Islands for investigating such problems in.

698. Would you desire or not to extend the area investigated south-eastward down the east coast of Ireland?—I do desire, and I hope we shall have co-operation from the Irish authorities.

699. Of course it would be premature to ask whether a scheme could be worked out for an extended area?—I think there is no difficulty in answering that; it certainly could be worked out.

700. That one steamer entirely devoted to this could work over that enlarged area?—No, I did not quite understand. I meant two steamers—an Irish steamer co-operating—if we are to have the larger area.

701. But if you had one steamer available for scientific research in the geographical area which lies between the north of Milford Haven and south of the Mull of Galloway, would you recommend something like the scheme you have as the basis, of utilising that steamer?—If you were going to cover all that area you would have to curtail this programme to some extent.

702. I did not say to cover that area, but if for in-

quiry in that area, you had only one steamer—would you, speaking broadly, recommend this programme or a modified programme?—I could answer that in a general way, "Yes," and I would recommend this programme, but I should probably recognise after discussing the matter further with Mr. Green that it would be necessary to get some observations on the Irish coast instead of some of those on the English coast.

703. Taking this or some other scheme as your basis you would defend your procedure scientifically, would you not, by saying that you have got to try and find out an unknown set of facts which you know you cannot find out perfectly?—Yes.

704. Which no human powers can find out perfectly?—Only approximately.

705. And you proceed by sample, the choice of the samples resting on experience and knowledge, is not that it?—That is so.

706. And then to the results of your samples you apply the well-known statistical methods of dealing with figures with the view of arriving at averages?—Yes.

707. You do not claim more for your scheme than that?—Well, of course, in addition we should come probably upon new facts. Would you include that under the term "samples," new forms, and numerous unknown stages?

708. I did not mean that?—The distribution of fish at the different periods of their lives, would that come under the term "samples"?

709. No, that is a separate part of the work?—No, that would come under the results of the statistical part also.

710. That I would say was an extra. But for the mere statistical purpose of trying to form an idea of the population of the sea, at different times of the year, and from year to year, that is all that you would claim?—Yes.

711. That it is a method of intelligent sampling digested on the well-known methods of dealing with averages?—Yes.

712. (*Mr. Archer.*) I gathered from your reports that as you have gained experience by actual work you have become more impressed with the complex nature of the problems to be investigated, although you have in no degree modified your opinion as to the necessity of obtaining the desired information?—That is so.

713. For instance, in your Report for 1892, before you started this work, you said: "And it should be borne in mind that it is only after such a series of exact observations have been taken for a year or two that we can hope to speak with any scientific accuracy of such things as 'spawning beds,' 'nurseries,' 'feeding grounds,' and the like." In your Report for 1900, that is eight years afterwards, you referred in the following manner to the investigations that in the meanwhile had been going on. "There is a great deal of valuable material in these statistics which, whether or not it leads to any definite conclusions, will at least help us to see what further observations are required, and what measure of success we may hope to attain in the proposed census of the sea." And in the programme you now put before us you advance as an argument in favour of investigations being made in the Irish Sea that on account of its smaller area it might be made a test case, with a view of ascertaining what measure of success we may hope to attain from the proposed method before undertaking the much wider and more difficult expanse of the North Sea?—Yes, but you notice that the aim in these passages that you have quoted from the 1892 and the 1900 Reports is a little different in the two cases. In the 1892 passage the aim was spawning grounds and nurseries. That information we have to some extent got, to a considerable extent, and I think that it was very much what I stated, viz., that one or two years work would enable you to determine certain spawning grounds and nurseries. The passage in the 1900 Report, I think, aims at a more exact knowledge, what I talk of as the census, so that in general terms I would agree with your question; that is to say, within limits, the more you work the more complicated you find the problem to be. But still, those two passages do not refer to the same thing.

714. But you think if we have opinions put before us by witnesses not having the same experience of actual work, and if they expressed any strong opinions as to the result that is likely to accrue, that we should accept such opinions with very great reserve?—Certainly. I quite agree with you.

715. Do you consider that the detailed method by which the work is to be carried out is practically the crux of the whole question, and that until this is settled we shall hardly be in a position to determine what organisation is necessary for carrying it out?—It is. The important thing is to settle the details of a scheme, and it is quite useless to discuss the matter in a general way until you know what the details are going to be. You cannot say whether a scheme is good or bad, is likely so lead to valuable results or not until you know exactly how it is to be carried out.

716. Then you refer to the fact of the absence of detailed method by which the work is to be carried out in the Stockholm and Christiania schemes?—Well, I speak of the biological part of these schemes not the hydrographical part.

717. You allude to the possible reason for that. May I refer you to page 55 of the Stockholm Conference, and you will see that the Chairman of the Biological Section in the 5th paragraph states the reasons?—In Roman numerals.

718. Yes. He said: "It is thereupon expressly stated on different sides that a more precise and detailed elaboration of the biological programme is desired. In consideration, however, of the fact, that on the one hand both time and the necessary preparation are lacking for this purpose, and on the other, that the opinions as to the carrying out of the work in detail, and as to the methods to be uniformly employed, have at the present time not yet been made quite sufficiently clear, such a detailed elaboration of the programme is rejected. This document is agreed to in the more general form, in which it has been proposed, in order that unanimous acceptance of it may be arrived at"?—I do not think that is a sufficient explanation. I might say that we cannot express any opinion upon your scheme until you agree upon a programme.

719. Now, you are aware that these sea fishery investigations are no new thing, that they were recommended by a Commission in 1885, and for many years investigations have been made in Scotland, at Plymouth, in Germany, Denmark, and in the United States?—Yes. May I say, in answering "yes," I can only do so in a general way. I still require to see whether any such investigations exactly meet the case.

720. Would you agree that if there is any data, and if a critical examination of that data is not made that it will be years before we have accumulated sufficient material from the proposed investigations, even to be sure that we are working on the right lines?—No, I do not think I would agree with that, because I feel fairly confident that we would be working on the right lines in this scheme.

721. We will come to that afterwards. You would not agree to that?—No.

722. Then, to come to the scheme itself. I see that you estimate that the wider area of the Irish Sea, north of Holyhead, contains about 10,000 square miles; that one special steamer should be equipped, and devote all her time to exploration; and that every observing station should be visited twelve times in the year, that is to say, once a month?—Yes.

723. Now, I find that a steam trawler having a spread of net 75 feet broad, working 15 hours a day during 280 days in the year—that apparently is longer than you propose to work—and trawling over each station at intervals of a month, would only be able to cover an area equivalent to 17 square miles in the course of the year. It is obvious, therefore, that if we work by special steamers we must work by means of samples taken at very wide distances apart, or else the investigations must be carried on a long number of years at great expense?—Yes, we are certainly working by means of samples, but my contention is that you can make use of a sample, as being a fair sample of a considerable area, when you know your area—when you know the conditions of your ground.

724. Have you any fact or figures to lay before us in support of that opinion?—I think we have. Our Lancashire results in these schedules that I spoke of where we have numerous trawlings over the Blackpool ground, or over certain other areas, and where I consider that we can recognise a constancy of result.

725. Do you not think it would be a good thing if the information in those investigations could be collated in order to show what evidence you have on that point?—An uncommonly good thing, and I have it

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in my mind, and I hope to have it done, and it is only the difficulty of getting it done that has delayed it.

725. With regard now to the investigations made in Scotland, have not four areas been selected there, or five in which to make investigations—The Firth of Forth, St. Andrews Bay, Montrose Bay, Aberdeen Bay, and the Moray Forth?—I doubt whether my opinion would be of very much value in connection with these Scotch investigations. Although I know them in a general way I have not gone into them very critically.

727. Do you not think there again then that it would be a good thing that we should look critically into those investigations to see whether they throw any light upon these points?—I think it important that that should be done.

728. Are you aware whether anything has been done at Plymouth which would have a bearing on the subject?—I am speaking merely from recollection—I do not think so.

729. In Germany Professor Hensen has been carrying out a number of investigations with regard to "Plankton" and other subjects?—Yes.

730. Could not those investigations be critically examined with a view of throwing light upon these points?—No doubt that ought to be very carefully examined. I am not clear that they will throw light upon our point.

731. But before coming to any conclusion, do you think that we should examine what has been done both in this and other countries?—Certainly.

732. Not merely by means of witnesses who give us their opinions, which are no doubt of great value as their opinions, but that we should for ourselves examine as critically as we can evidence with a special view to getting definite facts upon the question, not only of how often observations must be made over each ground in order to produce a fair sample, but at what intervals apart these samples must be taken, in order to give us a fair indication of the distribution of fish in any given area?—I think it very important that we should go into these matters, and consider all the printed evidence—you are referring to published evidence, I suppose?

733. Yes. Similar work is being done in Denmark and the United States, and the opinion you have expressed would apply to the expediency of going into the investigations made there also?—Yes, that is so.

734. There is one practical point which I should like to ask your opinion upon. I do not know whether you are sufficiently acquainted with navigation to know whether it is possible in winter gales or in fogs, when neither the land, the sun, or the stars can be seen, to pick up the station over which you wish to trawl?—You can only do it approximately. Of course there is the depth and the nature of the bottom; that is a help to you.

735. Do you know how near you can come to any given point?—No, it is only an approximation.

736. That is really a question on which we should get reliable information?—If you were to put that question to Mr. Dawson, for instance, he would give you a more important opinion than I can give.

737. Or possibly a navigating officer in His Majesty's Navy?—Yes, or the captain of a fishing vessel.

738. Then I see with regard to the information to be obtained you wish, "First, the distribution of fish in all stages of growth; secondly, the lower animals on which they feed; and, thirdly, a census of the sea." Now, with regard to the quantity of flat fishes on any given area, does not a disturbing factor arise when working by a special boat, namely, the increase or decrease in the number of commercial boats; do you know whether this disturbing factor can be got over by mathematical means?—Yes, I agree with you that it is a disturbing factor which has not been sufficiently taken into account. But, of course, it is one of the factors that make up the environment. There are other disturbing factors such as the temperature—the weather in general; and it is a disturbing factor that would disturb any scheme of investigations that you can imagine. I made a very simple experiment last summer which I think may be of interest to the Committee, in order to determine what the chances were of getting hauls very much the same time after time, and as to how much one haul affected another. I tried this in a large wooden tank which had about twenty square feet of bottom, and held about a foot of depth of water, and into this I put some hundreds of small stones, and made different experiments with a little net, something like a shovel with a perforated bottom which I set two laboratory boys to work day after day. The one boy was blindfolded, and did not know what he was doing. He put in the shovel and pushed it along the bottom until it reached the other side, and he lifted it straight up. The second boy took out the results of the haul, and counted them, and threw them back, and gave a general stir-round to distribute them again. First of all, I was struck by the constancy of the hauls. A few hauls gave the same average that another few hauls did. Then doubling the number of stones—may I say doubling the number of fish?—did not double the amount of the catch. If you put in 400 instead of 200, and if the average catch had been 16 for 200 you did not get 32 from the 400. You got perhaps 24—some number in the twenties. So that doubling the population did not anything like double the average catch. I found on talking this and similar fishery questions over with my colleague, the Professor of Mathematics, that he stated the whole thing was susceptible of mathematical treatment and that we might apply mathematical methods with benefit to such problems in the fisheries. I did not pursue it then, but I think that it is worth considering, whether we might not turn a mathematician on. Another point, I found it almost impossible to exhaust the population of the tank. Whenever you reduced it to a certain point you found it so difficult to catch more that you practically could not exhaust it.

739. The other disturbing factors to which you refer, *e.g.*, temperature, etc., it is proposed to investigate those with a view of seeing what their effect might be on the distribution of fish?—Well, cannot we investigate your disturbing factor also?

740. That is what I am wishing to know—whether it is possible by mathematical treatment to investigate that disturbing factor?—I am uncertain from my own knowledge—I am not sufficient of a mathematician to say; but speaking from my recollection of my conversation with the mathematician, I think it is.

741. Would it not, therefore, be advisable to get a statement from him of the method by which he proposed to treat this mathematically in order that we might judge of it for ourselves?—We ought certainly to get an opinion from some mathematician.

742. Now the investigations recommended by the Christiania and Stockholm Conferences may be broadly divided into two divisions, first those for ascertaining the distribution of fish in different localities, and in different seasons, and secondly those for ascertaining the causes of the fluctuations in their distribution. Now, if we find that there is at present no specific evidence on the points to which I have alluded, namely, taking the value of any samples which may be taken, what would you say to a proposal to investigate, in the first place, the relative abundance of fish in different localities and in different seasons on a broad basis by means of the present commercial trawlers, and then subsequently to investigate the causes why one ground is more prolific than another by means of special steamers?—I would like to carry on both simultaneously. I would like to start the more scientific investigations along with the statistical enquiry.

743. But my point is rather this, that I suppose we shall be limited to some extent as regards funds, and that to fit out a steamer, such as you propose, will cost £9,000 and £2,000 a year to keep her up, and that sum would go a very considerable distance in collecting information from a very large number of trawlers working in the North Sea?—But, then my point is that we shall get a great deal of additional information from the scientific work that you will not get from trawlers.

744. But would not that give us a basis upon which to start, which would make our subsequent work by scientific steamers of very much greater value, and would in the meantime enable us to adopt some measures for the redress of some of those grievances which are particularly pressed upon us by fishermen?—I think there are two points in your question. In answer to the first one, I say we have sufficient basis at present to start the scientific work on.

745 I think you have expressed the opinion that we should examine the work that has been done with a view of seeing whether that is the case. If it is the case we can start straight away, but if it is not the case, what would you think of getting information on a broad basis, such as I have suggested before we begin work by special steamers?—I think we have sufficient basis to enable us to know what we want to investigate in such

an area as this (the Irish Sea). I do not consider that we would be wasting our efforts. The second part of that question (No. 744) referred to whether we can get information from trade statistics sufficient for legislative purposes—was that it?

746. No. If the information which at present has been collected is sufficient to give us a basis on which to lay down a detailed scheme of work for special steamers then probably we could go straight away ahead, but if the information is not sufficient, would it not be better, in the first place, to try and get information, on a broad basis, from commercial trawlers working in the North Sea?—If we could get that information in a reasonably short time, but I think it would be a pity to postpone the scientific investigation for a number of years, because I feel that the scientific work will give us a great deal of additional information that we cannot hope to get by the trade statistics.

747. (*Professor Thomson.*) Do you think the area that you speak of furnishes as much material to work upon as the North Sea?—For its size it furnishes more. I am convinced that it is a richer ground for its size.

748. Equally varied?—Equally varied.

749. Could you tell us approximately how much of the 10,000 square miles can actually be trawled?—I wish you would repeat that question to Mr. Dawson.

750. I think you would be doing us a great service if you could explain a little more fully how the statistical evidence which you propose to collect differs, on the one hand, from the trade statistics, on the other, from those of Dr. Fulton's method, and in the third place, from those suggested by Professor Henking in the supplement of the Christiania Conference?—The difference from the trade statistics consists in including small fish and unmarketable fish, and "Plankton," and the various other animals that are not dealt with at all by the commercial trawler. It does not differ from Dr. Fulton's method except in taking the observations in a rather more detailed way, and my hope would be that it would be taken with greater regularity and more frequently. As to the Christiania scheme, can you show me the passage that you referred to?

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751. It is Supplement No. 7?—(*Looking at the page.*) Of course, my point is that this is not a detailed scheme.

752. (*Chairman.*) I do not quite apprehend how far you think the value of these investigations—these periodical visits in different areas—could be affected by the meteorological conditions. It is almost indefinite the extent to which they may be?—Do you mean simply that a storm would prevent you going out in a particular month?

753. No, the movements of fish in consequence of storm or temperature?—I do not think that it is almost indefinite.

754. It is my lot to live at the northern part of your area, on the shore of Luce Bay, which in calm weather is often full of herrings and mackerel; and supposing you visited that bay on the 10th August this year in fine weather you would find a large quantity of these and other fish there, whereas if a sou'wester was blowing on the 10th of August next year you would not catch a single mackerel?—You are instancing fish, such as mackerel, that are affected very much by the weather. You could make allowance; but in the second place your remark would not apply to such fishes as the sole, and other flat fish.

755. (*Mr. Spring-Rice.*) All this has not been about herring and mackerel except in an incidental way, and you have been studying principally flat fish?—Yes.

756 (*Mr. Pelham.*) The supply of herring and mackerel is illimitable?—Yes.

Mr. E. J. Allen, called; and Examined.

757. (*Chairman.*) You are honorary secretary to the Marine Biological Association of the United Kingdom?—Yes.

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758. And director of the permanent staff at their laboratory at Plymouth?—I am.

759. You entertain some pretty definite views, I think, as to the possibility of developing the sea fisheries of Great Britain?—Yes, I think that if we had accurate information as to the exact condition of the fishing grounds something might be done to develop the deep sea fisheries, and also that something might be done in the way of the rearing of fish in confinement in closed areas.

760. You think that nothing can be done until we have exact information?—I think that practically nothing can be done until we know the factors which control these things—until we have the necessary information.

761. Does not that postpone any prospect of action almost indefinitely?—I would not say almost indefinitely.

762. Over a long period of years?—A great deal of further investigation is certainly required before any action would be justified in my opinion. I refer more especially to the deep sea fisheries as distinguished from the local and in-shore fisheries.

763. What is the precise meaning you attach to development? Is it the adoption of more efficient means of capture, or is it what has been carried on to some extent in America, an attempt to replenish the fisheries?—I should say it was an attempt to replenish the fisheries or to make them more productive; increasing the quantity of fish available on the present grounds rather than increasing the area of capture.

764. By regulating the periods of capture?—There are many means which suggest themselves by which this might be done. For example, the introduction of regulations which would prevent certain grounds being fished over during the whole year or during a part of the year, or which would prevent the destruction of immature fish; or there might be regulations as to the size of mesh and means by which the fish were captured, so that the smaller fish would remain in the sea until they had grown larger.

765. But there is a third, is there not, which has been adopted largely in America—artificial hatching?—That is a question which cannot be attacked until very much more information has been obtained. I do not think that at present we are in a position to say that artificial hatching is of any use. It is, in my opinion, distinctly one of those questions on which further information is required before definite steps can properly be taken. I do not say that the thing will be impossible when we know more, but I would maintain very strongly that in the present state of our knowledge one is not justified in going to any large expenditure in actually carrying out work of the kind.

766. So much for deep sea fisheries. What about in-shore fisheries?—In-shore fisheries are much more capable of control. For instance, in the shell fish industries a great deal has been done, and can be done. In the way of closing definite areas more can be done in-shore than can be done outside.

767. Can you give us an outline of the work of your association?—I have submitted a printed account of what we have done, and also a list of the publications which have been issued by the association. I do not know to what extent you would wish me to go into details as to the work which has been done. I think I could not do better than read the portion of the printed account which deals with this matter:—"Practical investigations upon matters directly connected with sea fishing, however, are constantly in progress, and are under the charge of a specially qualified naturalist. The investigations of this kind already carried out by the association cover a large ground, and embrace a variety of subjects, among which the following may be selected for notice: (1) The reproduction and development of fishes, the determination of the characters of egg, larva, and young at all stages of growth, with experiments on the rearing of fishes in captivity, and on their rate of growth in confinement and in the sea. (2) The size at which maturity is reached in different species, the variations which this relation undergoes in different localities, the characteristics of local races of fish. (3) The food supply and sense organs of fishes, with experiments on their methods of feeding, and on the manufacture and employment of artificial baits. (4) The distribution of flat fishes at different stages of growth, their migrations, the destruction of immature fish in particular grounds, or by particular methods of fishing. (5) The natural history of migratory pelagic fishes, including the pilchard, anchovy, and mackerel, with reference to their reproduction, racial peculiarities,

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and the extent and direction of their migrations. (6) The relation between the distribution, seasonal migrations, and varying abundance of fishes, and the physical conditions of the sea." All those are questions on which our naturalists have been directly engaged, and upon which papers have been published in the journal of the association or elsewhere. Of course, in addition to that a great deal of purely scientific work has been done in relation to the distribution of the marine fauna? Some of that work has been done in very great detail; particular areas have been mapped out, the nature of the bottom carefully investigated, and the whole animal population in those areas described, so that we can get an exact knowledge of the whole fauna of which the fish form a part, and of the exact conditions to which the fish are subjected, not only after they are full grown but at all stages of their growth. I may refer also to the printed list of publications which gives a classified list of the papers in which the results of the researches carried out by the association have been published. I might explain, further, that at Plymouth we depend largely on the work of naturalists who are not definitely employed by the association, who visit the laboratory for longer or shorter periods, and carry on investigations on their own account. Our own staff is somewhat limited.

768. You have a vessel?—We have a vessel now of 69 tons. We have quite recently bought her—within the last six or eight months. We have been using her for the last six or eight months. Before that we had a small vessel, which was not much more than a steam launch. The present ship gives us a fair command of the coast, especially in the summer time. We have not had experience with her during the winter time yet, so that I cannot say what we shall be able to do in the more stormy part of the year.

769. What are your principal sources of revenue?—Our principal source of revenue of course is the grant from the Treasury of £1,000 a year. Then we get a grant of £400 a year from the Fishmongers' Company, and we get about £140 in annual subscriptions from private individuals—the members of the association.

770. Do you co-operate with any public bodies such as County Councils?—We have worked to some extent with the Devon County Council. We have carried on investigations on their behalf, and they have helped in meeting the expenses of the investigations. We are at present engaged in an investigation of that kind in the bays on the South Coast of Devonshire, and by an arrangement with the Technical Instruction Committee of the Devon County Council we have on the staff a naturalist who devotes part of his time to the fishery work, especially to the investigation of the bays, and the rest of this time to the technical instruction of fishermen under the County Council Committee.

771. It is mentioned in your statement that the Cornish Sea Fisheries Committees, as well as the Devon Fisheries Committee are connected with you?—As to the Cornish fishery work, I have been a member of the Sea Fisheries Committee, and have some knowledge of their work, and I have followed Mr Cunningham's work under the Technical Instruction Committee. The suggestion I wish to make is that it would be an advantage if the work of the Sea Fisheries Committee and of the Technical Instruction Committee could be brought more into harmony when dealing with local investigations and questions of control.

772. What is this Sea Fisheries Committee mentioned here?—The Sea Fisheries Committee is not a Committee of the County Council, but more or less an independent body, one half of its members appointed by the County Council, and the other half by the Board of Trade.

773. And they are District Committees?—Yes.

774. (*Mr. Pelham.*) They do not make you a grant?—No; the Devon Committee have paid for a portion of these special investigations.

775. (*Chairman.*) Have you been attached to the association since 1888?—No, I was appointed director in 1895—seven years ago. I had worked a good deal at the laboratory before that as a private worker.

775. What view has your experience led you to take as regards centralisation or de-centralisation?—Certainly for the deep sea work some kind of central control is necessary. Take, for instance, the North Sea—you cannot divide it according to the geographical divisions of the land. You cannot consider one part of it without considering the other. Then you cannot consider the North Sea without considering the English Channel, because the southern part of the North Sea may be regarded from many points of view as a continuation of the Channel. The fauna and the physical conditions are more or less continuous in the southern part of the North Sea and in the Channel, and the currents entering the North Sea from the Channel are of course very important factors in deciding the distribution of the fishes. At the same time, while I am of opinion that a certain amount of central organisation is necessary, I think it is equally important to bear in mind that everything possible should be done to encourage individual initiative by the different workers; that the workers should not be bound down more than is necessary to carry out some hard and fast system. And therefore I should rather favour three or four more or less independent organisations acting under one general control than the formation of one body ruled by one head, who would regulate the details of the whole work. It would be better, for instance, to have separate organisations in England, Scotland and Ireland with a Director-General who would generally control the whole. But I think that it is very important that as much liberty of action should be left to individuals as possible. It is always a very important factor in the successful carrying out of scientific work.

777. But sufficient provision should be made against overlapping?—I do not think there is really very much danger of that. Of course it depends on what you mean by overlapping. If you mean going over the same ground, it is generally in scientific work an advantage that one man should check another. In trying to get at the truth in these matters a great many attempts are made, some of which are not altogether successful, and they are often not as successful as their authors think they are. We are all carried away by our own work, and there is not much serious harm done by several people working over the same ground. It tends rather to accuracy of result and care in work. If you have an investigation made once, and that more or less under official auspices, there is always a tendency to regard the result as absolutely fixed and certain, whereas very often it wants a good deal of revision and reconsideration.

778. You think there is danger of investigators acting on *a priori* grounds or preconceived ideas?—I think when an investigation is made, and a person comes to some conclusions, and publishes his results, unless those results are checked by other workers they are liable to go rather beyond the mark, and perhaps not to be quite accurate. All scientific work wants repeated checking, and the more independent workers you have the more likely you are to get at the real facts of the case.

779. (*Mr. Pelham.*) Should these scientific experiments be conducted in connection with practical fishery work or done by quite a separate body?—That depends upon whether they deal with practical fishery work or not. If you refer to fish culture and work of that kind, I should recommend keeping the scientific investigations in close touch with any work of the kind. When it comes to questions of administration the matter is rather different. It is better for the scientific work to be kept as separate as possible, the scientific body to be entirely under scientific control, and to act in the position of advisers to the administrative body.

780. And that they should refer questions to the scientific body?—Yes.

781. Supposing money is devoted by the State to these investigations, would there be any risk of the scientific body spending the money on important research, but which was not directly connected with practical fisheries?—That is a question where it is very difficult to draw the line. It seems to me that you must treat the sea as a whole, the life in the sea as a whole. You cannot investigate the fishes without studying the life conditions of the other animals. You have to take a broad view of the whole matter, or you are not likely to get the result you want.

782. You have read the reports of the Hydrographic Conference, I suppose?—Yes.

783. It appears from those that some of the countries are interested in meteorological subjects?—Yes.

784. They might not be connected directly with the supply of fish, might they?—I think they would very likely be. The kind of problem which one is very often asked about is the problem of the reasons which cause the migrations of fishes. Such migrations probably depend upon meteorological conditions ultimately. If we are to be able to follow these fishes, and to tell the fishermen where to shoot their nets and find fish, the best way is to study the meteorological conditions from

the beginning and try and get a more complete knowledge of the causes of the migrations.

785. Supposing the Government of Great Britain were anxious to know whether it was desirable to close certain parts of the sea area for trawling, it would be of importance that the inquiry should be directed specially to that point, would it not?—Yes, that would be important; that would be a definite question addressed by the administrative body to the scientific body.

786. A very eminent naturalist might devote the whole of his time to study some fish which might be of great importance from a scientific point of view, but have no particular bearing on that particular question of the closing of the sea area?—You assume, I suppose, that the money would be granted definitely for fishery work of this kind.

787. What I meant was that it is important not to put it in the hands of the same people who are carrying out the scientific question without close connection with the administrative body?—With a close communication between the two bodies certainly.

788. You work for two County Councils—Cornwall and Devonshire?—Not actually for Cornwall, only for Devonshire.

789. Any other sea fishing committees or salmon conservators?—I do not think we have done any practical investigations for any of the other committees. When working in the North Sea some years ago our naturalist, Mr. Holt, was in communication with several of the committees, and gave lectures to the fishermen, but I do not think we have done any practical investigations for others.

790. Was that work carried on at Grimsby by Mr. Holt done at the expense of the association?—Yes, it was done by a special donation given by a private gentleman to the association.

791. How long was he in conducting that?—Four years.

792. He has practical information about the East Coast fisheries?—Yes, the fisheries of Grimsby and Lowestoft. Mr. Holt was there three years and Mr. Cunningham for one year at Grimsby, Lowestoft, and Yarmouth.

793. Have you considered the question of fishery statistics?—Yes, I have thought a good deal about them. The kind of statistics required from the scientific point of view are rather different from those required by the trade, for in order to study the fishing grounds we want to know the quantity of fish coming from particular areas; from the point of view of the fish trade, what appeared to be wanted is the quantity of fish landed at given ports, and the two things are often quite different.

794. If the system of collection of statistics is made more complete so as to give the places from which the fish come, that would be of value in your opinion, would it not?—Certainly.

795. In addition to what might be obtained by scientific men on special boats?—Certainly.

796. In fact, the scientific statistics obtained by special boats would not be satisfactory by themselves, I presume?—No, I think there should be a collection of statistics of another kind altogether from as many different boats as possible, but these statistics would be directed to particular investigations rather than being quite general.

797. You could not expect to get information from the crew of an ordinary trawler as to the habits of fish?—You could only get that by naturalists being on board many ships; that would be of great value.

798. It would be important in order to make the investigations complete, first of all, that there should be separate boats and investigations conducted thereon by scientific men in the first place?—Yes.

799. Secondly, you think that the trade statistics should be made as complete as possible?—Yes.

800. And then, thirdly, do you think that additional work should be done by skilled investigators on board ordinary trawlers?—Yes, I think that that would be very likely to prove as economical and as effective a way as any for getting information of a certain kind.

801. I suppose it is rather difficult to get the accommodation on the ordinary trawler?—I do not know whether it would be possible to get such accommodation regularly. We have always found the trawlers very willing to take naturalists for an occasional voyage.

802. It would be somewhat uncomfortable for the naturalist?—We have to get used to that.

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803. (*Mr. Spring-Rice.*) The Marine Biological Association has at all events supervised work carried on at Grimsby?—Yes.

804. So that you do not feel that you are necessarily a local body?—No, we have always endeavoured to carry on what work we can. Wherever we have seen opportunities we have tried to take advantage of them.

805. But looking at it as a body whose headquarters are at Plymouth, could you define at all what we may call a natural territory, in which your work carried on from Plymouth would properly lie?—I should say the English Channel, and possibly we might include the southern part of the North Sea, especially if we could have anything in the way of a branch depôt somewhere near London on the North Sea coast.

806. I gathered from a statement that you made that there are scientific reasons for that?—Yes, there is a continuity between the southern part of the North Sea and the Channel.

807. And also, if you had a vessel of the size of a steam trawler you could work it up as far as that?—Yes.

808. How far round could you work westward and southward?—The regular steam trawlers from Plymouth work largely in the Bristol Channel, that is the whole region between the north coast of Cornwall and Devon and the south coast of Ireland, and also down into the Bay of Biscay.

809. I mean with a vessel like a trawler for scientific purposes, what sort of ground could you cover?—I do not see why we should not cover the whole of that area if the ship were equal to a commercial steam trawler.

810. I am not quite sure what you mean by the inshore fisheries and the sea fisheries proper. You have mentioned in-shore fisheries in connection with shrimping?—I should take the natural limit over which the fishery committees have power—the three-mile limit.

811. As a matter of practical fishing, are not there a lot of small people along the coast who fish for sea fish beyond the three-mile limit?—That is so.

812. For the problems which we are considering they would fall rather under deep sea fisheries than under coast fisheries, would they not?—The main part of their work would be inside the limit, I suppose; the kind of fishing I have in view is that carried on by the smaller boats.

813. Can you draw a good distinction, speaking roughly, between the problems inside and those outside the three-mile limit?—They overlap to some extent. We could not solve the problems outside without knowing the inside, because so many of the young fish are in-shore, but the great thing about the region inside the three-mile limit is that it can be actually controlled: the County Councils can prevent fish being taken, whereas when you try to control the region outside the three-mile limit international complications and the difficulties of policing come in.

814. From a more general point of view could you study the problems arising outside the three-mile limit without thinking much of what happens inside?—No, you would have to bear the inside region in mind all the time.

815. So that if the conditions of the inside region in one part of the United Kingdom and another differ materially that would be an important factor in considering the problems of fishing as applied to those two districts?—Yes.

816. (*Mr. Archer.*) Have you made any observations at present by means of special steamers?—Only with our own steamers; and of course, when Mr. Holt was in the North Sea he went out a good deal on the steam trawlers working from Grimsby—both Mr. Holt and Mr. Cunningham did.

817. Have you any figures showing the number of investigations which must be taken at each place in order to give a fair sample of the quantity of fish on that ground from year to year?—Well, the figures which we are actually getting now from the bays on the Devonshire coast would, I suppose, be the most suitable for the purpose. What we are trying to do is to examine definite grounds, taking three or four hauls on each, every month.

818. Have they been taken for a sufficient length of time?—Not yet, we are still doing them.

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819. You have no other figures of that nature?—None that would be useful to show what you want.

820. And you have not either observations or figures showing the variation in the quantity of fish taken in grounds close to one another, or grounds having the same physical characteristics?—No.

821. (*Professor Herdman.*) I have only one or two questions to put to you. First, taking your summary which you have put before us, I think I gathered from an answer to the Chairman that when you talk of the development of the deep sea fishery you do not mean increasing the fishing, you do not mean exploiting the fishing and finding new fishing grounds?—No, I mean actually increasing the amount of fish on grounds already worked.

822. Indirectly by legislation?—Yes, or if it could be done by hatching or in any other way.

823. Stocking?—Yes.

824. Then you say a few words further down: "Before any measures can be taken for the control of the deep sea fisheries a large amount of detailed information is required as to the condition of the fishing grounds at all seasons of the year." Do you think that we should be likely to get such required information if we took part in the international scheme?—I believe that we should if the international scheme were carried out properly, as the Conference recommended it. If it were carried out fully we should get that information.

825. But can you make out from the programme in what manner it is proposed to be carried out. You say "carried out properly." It depends upon what you mean by that?—It depends upon the number of vessels you have working and the amount of work you can get out of them.

826. And where you work and when you work, and all those different details?—Yes.

827. You do not find such a detailed scheme in the programme?—I find that the programme covers investigations of that kind.

828. Yes, in general statements?—Yes. I believe from my reading of the programme that it was the intention of the Conference that such investigations should be carried out.

829. Do you know the scheme that Mr Garstang has submitted to the Royal Society in manuscript?—That is with reference to this?

830. Yes, with reference to Great Britain's possible part in such a scheme?—Yes. I am afraid I do not remember the details of that particular manuscript, but I have a general knowledge of it.

831. He suggested that one new steamer would be sufficient for the purpose?—I am not sure that he suggested one—I thought two steamers.

832. But he talked about making use of your Marine Biological Association steamer as one of them. He considered it necessary to build one new steamer; but apart from Mr. Garstang's suggestion, would you say that one steamer would be sufficient?—Not to do it properly.

833. How many then?—Two at the lowest estimate.

834. For the whole of the British coast?—No, that will be for the North Sea and the English Channel.

835. And you mean one for each of those areas?—Practically one for each area.

836. So that would be one for the North Sea?—The one steamer would take the northernmost part of the North Sea and the region north of Scotland, and the other steamer the English Channel and the southern part of the North Sea.

837. And the steamer taking the northern part of the North Sea, would that steamer cover the ground efficiently—I mean the British part of it?—Of course, that is a very difficult question to answer. The area is a very large one I know. No doubt two steamers would do it better than one.

838. But have you made any plans either on paper or in your mind; have you figured to yourself how such a steamer would behave, where the would go, and how often she would trawl, and where she would trawl?—I have thought it out on those lines, and the conclusion I arrived at was that by spending a fortnight out of each month on the hydrographic work, in running along the lines recommended by the Conference, she would have the remaining part of the month for the trawling. That would be about the time devoted to trawling, less, of course, times that were spent in harbour for repairs.

839. And you must allow a good deal for that?—Yes.

840. Will that leave you anything like sufficient time to conduct a sufficient number of trawlings to give you any reliable results?—No, I suppose it would not on the whole of the northern part of the North Sea; it would not be sufficient for the results that you would really want in that region.

841. Do you see any special advantage that the international scheme would have over a well planned out national scheme?—I think one of the great arguments for the international scheme is of a political nature: if you get the international investigation, than you have the prospect of getting international control. By the international investigation also you cover a very much larger area, because not only the English vessels, but the vessels of Continental countries will be used for the work.

842. They leave a very large part of the area to Great Britain. It seems to me that they ask us to contribute more than they contribute?—Of course our fisheries are much larger than theirs.

843. Then it is more with a view to future advantage in the way of legislation—that is, control, that you want this international scheme carried out?—That is one strong argument in favour of the international work. At the same time the work would be better done if we was in connection with the Lancashire County Council which is included in my list.

844. As to the present organisations of the United Kingdom, you have in England the Marine Biological Association, of which you have given details, but has not some work been done at Port Erin?—I thought that was in connection with the Lancashire County Council which is included in my list.

845. It has nothing whatever to do with it?—I thought the fishery work was in connection with the County Council.

846. No. Ought an addition to be made there?—From my knowledge my idea was that it was the other way about. I have not got the details about it. That is a question which you are more capable of dealing with than I am.

847. With regard to Scotland, has work not been done at the Gatty laboratory?—I believe that most of the fishery work at St. Andrews has been done in connection with the Scottish Fishery Board.

848. You speak a little further on of the advantage of having technical education in fishery subjects placed under the same management with the District committees work. Do you think it would be an advantage?—Yes.

849. Well, then, you also in the same paragraph speak of more adequate powers being granted for fishery research and experiments in fishery culture. Would you contemplate that the fisheries investigation, the scientific research, and the administration of fisheries, and the technical instruction should all be in the same hands?—I certainly think that the technical instruction and the researches might be in the same hands for the local fisheries. I think they should be in touch with the administrative body, so that there would be a scientific body which the administrators would naturally consult if they wanted information in connection with the legislation. As a matter of fact, I suppose in many cases—I know it is so in Devon and Cornwall—the members of the Sea Fisheries Committee, who are nominated by the County Councils, are generally much the same as those nominated on the Technical Instruction Committee on Fisheries. In Devon the chairman of the two committees is the same as well as several members of the committees.

850. You are in favour of a central organisation for England?—Yes.

851. I want to know what relation that would have to the control of the district committees?—The practical working out of the scheme I suggest would be that the central organisation would have power to make grants to the district committees for special investigations into local fisheries.

852. (*Mr. Pelham.*) You spoke about making some fishing experiments in Devonshire bays?—Yes.

853. Is that for the County Council?—We are in communication with the County Council Committee, and

they are going to make a grant towards the expenses. We have kept in touch with them all through.

854. How long has that been going on?—More or less for the last four or five years. Within the last three or four months we have done it more seriously, because we have had a better vessel to do it with.

855. Has it reference to any particular kinds of fish? No, it is more in connection with the closing of the bays. The most important fish concerned is the plaice.

856. It is in connection with the Fisheries Committee, I presume?—Yes.

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Mr. R. A. Dawson, called; and Examined.

857. (*Chairman.*) You are Superintendent of the Lancashire and Western Sea Fisheries District?—I am.

858. You have been Superintendent of the Lancashire Sea Fisheries before the amalgamation of the Lancashire and Western Districts—since the year 1891?—That is so. Only last year, eighteen months ago, the two Committees amalgamated, and I got the appointment on the joint committee. Before that I was Superintendent of the Lancashire Fisheries since the commencement of the work.

859. And previous to 1891 you were familiar with the fishing grounds in the Irish Sea?—I used to spend a great deal of time on the fishing grounds there—from my boyhood I may say.

860. Have you any suggestions to offer as to the best means of utilising any help which the State may be inclined to devote to fishery work, and to researches?—Yes, the suggestion that I should make—of course, I am speaking of the Irish Sea—I think it is in the evidence, that a steamer should be provided by the State which should be entirely devoted to scientific research in the Irish Sea, and my reason for mentioning the Irish Sea is that it is so compact as compared with the North Sea, and you also have better opportunities of carrying on the work on the grounds. For this reason, that they are more protected as regards shelter, and they are close to one another, and your distances from harbour are very short, and you also have there better material to work upon, that is, not in the quantity of fish but in the easier way of getting at them. For instance, you have on the sand your grounds where plaice are, and you go a little further and you find the mud where the sole grounds are, and then the nurseries for the small fish adjacent to those grounds. As a matter of fact, I always look upon the Irish Sea as a model farm for fishery work as compared with the larger area of the North Sea.

861. Would you isolate it in any system of research or administration from other areas in the British seas?—I should as regards the work to be done. In my opinion there is no use in undertaking work of that nature unless it is done thoroughly and perfectly, and, to my mind, the Irish Sea would take the whole time of any one steamer.

862. I do not think you quite apprehend my question. I did not make my meaning quite clear. By "isolation" I did not mean the exclusive use of a steamer or staff, but would you have it conducted under the supervision of a central department of the United Kingdom, or do you think it would be better done by an independent body working on the spot?—I think it would be better done by a central department for England rather than for Ireland and Scotland combined.

863. Why so?—My reason for that is, first of all, as far as I understand, in Scotland there is a certain amount of work going on now, and also in Ireland, but practically little in England, and I think it would be rather a pity to interfere with them at the present time. And again if you have a central body composed of the three countries is there not rather a tendency for each particular country to wish to have the work done on their own grounds?

864. You are asking me questions, and I am not prepared to answer them?—I am giving you my opinion that way. I am not asking questions. It is my opinion that it might be so.

865. Do you not think it desirable that a uniformity of system should be observed in an area comprising the whole of the British seas?—Yes, but I thought you meant as to the conducting of the work from the different countries.

866. What I said was under the control of a central department?—The work, of course, must go on simultaneously.

867. That is what you want to arrive at?—Yes, in the different waters.

868. Would it be an advantage or otherwise, that those bodies, working in prescribed areas, should be wholly independent of each other, or should they be under the general direction of a central body?—It would be better to be working separately.

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869. And you have no reason to give for that except that it would be a pity to interfere with the work now going on in Scotland and Ireland?—That is one reason, and more work could be done by working independently.

870. Then, to carry it a little further, do you think there is any promise of a good result in an international scheme of observation and investigation as has been suggested?—For the North Sea, do you mean that?

871. Yes, that was suggested?—Yes, there is no doubt that the more research you get the more knowledge you have, and I should say that good is bound to come out of it.

872. I was asking about the international character of the work, not about the amount of research. It is the international co-operation about which I wanted to obtain your opinion?—Yes, I think it would be of use, especially as a basis for international law as to fisheries—as to the laws controlling the different fisheries.

873. How would it be possible to carry out such an international system if the shores and seas in this country were occupied by a number of independent bodies such as you suggest?—As regards the independent body. I was speaking of the British fisheries. I do not see that any harm could be done by co-operating with an international body as well.

874. But who is to co-operate with the international body, if you do not have a central department of fisheries in this country?—I take it the central body would do that.

875. (*Mr. Pelham.*) Have you many steam trawlers in the Irish Sea?—We have a fair number, of course, nothing like the number they have on the east coast, but we have steam trawlers fishing from Fleetwood, and also from Milford Haven in the Irish Sea, and also from Liverpool.

876. But the proportion of steam trawlers is less I suppose, as compared with other means of fishing, than it is in the North Sea?—Yes, in the North Sea. Of course, the proportion of steam trawlers in the Irish Sea is very much smaller.

877. Would experiments which are made in the Irish Sea be of any assistance or help in considering the condition of the North Sea?—I should say that it would, for this reason: you would be able to find out—I suppose the great question is that with reference to whether the prohibition of the landing of fish under a certain size would do good or harm. I think in the Irish Sea that would be very easily ascertained; that is, you would find out whether the small fish and the large fish mix together, or whether they lie on separate grounds.

878. I suppose the temperature of the water is very different, is it not?—I could not tell you that as regards the North Sea.

879. What are you engaged in at present? Are you conducting any scientific investigations at present?—Yes, but they are not carried on regularly, and in my opinion they are not sufficiently numerous. We make hauls over the different fishing grounds, and the quantity of fish taken are tabulated, and the temperature of the water is taken, and the nature of the bottom, and the density of the water, and a few other observations of a like nature.

880. How soon would you go over the same ground again?—That would entirely depend upon the work of the steamer. It is not carried on regularly. If the steamer happens to have a little time at her disposal she will go to a certain ground, and if she has not she cannot be spared for research work.

881. What else is she doing? Is she doing police work?—Yes, that is the principal work she has to do.

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882. How often do you think that a trawl should be taken over one particular part of the sea?—The oftener the better if you want to get the proper results from it.

883. I mean how often would it be practicable to do it if you had a steamer devoted entirely to that purpose?—At least once or twice every month it ought to be done. You might trawl over a single ground, and your haul might be a good one on that ground, and a little later you might be there again and find nothing on it, and the fish might go back in another week. It depends upon how the hauls are taken. As many as possible should be taken.

884. If you take a haul to-day is it a fair sample of what will be found to-morrow?—One day would not make much difference but a week might make a great difference.

885. When you go a second time, can you ensure going over pretty well the same ground?—Yes.

886. You can actually trawl over the same line?—Yes. What I am alluding to now is this: If you make certain stations on particular grounds, I take it that those stations would be in such a position that they would be within an easy run, either from a lightship or a headland, and as regards a particular position in the Irish Sea, soundings would greatly assist in finding it. I am not alluding to the depth but to the nature of the bottom.

887. What would be the length of your trawl?—The one we are using now?

888. Yes?—About 30 feet.

889. If you had one about 50 feet, would you be travelling over nearly the same ground?—I do not think you could hit it with the 50 feet trawl, but approximately you would be on the same ground.

890. When conducting those experiments do you come across other trawlers?—Yes.

891. Then you have to divert your course very often?—You have to keep clear of them.

892. What is your experience as regards two hauls on the same day, working side by side—would they take about the same amount of fish?—Two trawlers trawling alongside one another, do you mean?

893. Yes?—They would at sea. But in an estuary it would make a good deal of difference.

894. Take—I mean your area of the Irish Sea—the trawling ground round the Isle of Man—would two trawlers trawling side by side, within a few hundred yards of each other, take very much the same amount of fish?—They would, given that their gear was similar, and the circumstances under which the trawl was dragged were the same.

895. Might not it be that the character of the sea bed was different?—Not within a very short distance like that. I am speaking of some distance from the land.

896. You would not get a harder surface at a particular spot, and then come to softer or a more muddy surface afterwards?—Not if you got well on to a particular fishing ground; you drop off the sand on to the mud, and you get a difference there, but I take it you would not fix a station on the boundary line between the two.

897. Supposing you took a certain number of fish in March. If you took less or more during April, May, June, and July, it would not necessarily follow in that short time that the fishing was deteriorating or improving?—No, that would have to be found out by the length of time you were on the different grounds.

898. I suppose next year you will compare the March of next year with the March of the year before?—Certainly.

899. Sometimes the season is a more advanced one than another?—That is so.

900. How long would you be in getting enough experience and number of experiments sufficient to form a just average of the condition of the population of the sea?—I should say a considerable number of years. I could not tell the exact number, but certainly for a considerable time. I should not like to name the number of years. I do not know.

901. It would not be done in two or three years?—No.

902. Would you attach much importance to trade statistics if they were made more complete?—The returns from the trawlers, I take it you mean?

903. Yes?—Yes, I should.

904. Have you had any experience of that sort of thing? Have you had anything to do with statistics from trawlers?—No, except taking them from different captains. We have asked them what amount of fish they have landed, and so on.

905. Have you asked them where they have caught the fish?—Yes.

906 Have they been willing to say where?—Not on all occasions.

907. And when they have given it is it dependable?—To a certain extent. Of course, if a steamer has been in the Clyde which ought not to be there, she would say she had been somewhere else.

908. If they came across a particularly good place they would rather keep it quiet?—They do. I have known a steamer followed for weeks because she was getting large quantities of fish, and the skipper stopped off Peel in the Isle of Man until the others had gone away, rather than let them know where he was trawling.

909. I suppose it would make a difference if you could assure them that the particulars given would not be made public?—Yes, it would have a good effect. If they all had to fill up a return of the fish taken I do not think it would be much trouble. They must give a return of the number of different boxes now.

910. Do they know, as a matter of fact, where they have caught the fish?—Yes

911. How long do they stay out in the Irish Sea—a couple of nights?—Seven days, the steam trawlers. The other boats stay the most part of a week if the weather is suitable.

912. In one week would they fish in many places?—Occasionally they would. For instance, they will come out of harbour and run to a certain ground which they will try. If they catch fish there they will stop all night fishing. They will put a lighted [Dan] buoy upon it, and fish about this buoy till the fish get scarcer. But if there is no fish there they will go immediately to another ground, and so on from one to another.

913. What would the length of a trawl generally be before they took up the trawl—what would be the distance that they would go?—They have the net down on many occasions five and six hours, and they keep trawling backwards and forwards and going round just according to the state of the ground on which the fish lie. In some instances they will travel over a long distance of ground, but in one small circle. I am speaking of the steam trawler.

914 The trawler has no difficulty in turning?—Not a steam trawler. A sailing trawler will drag his gear with the tide. The tide, unless it is very strong, makes little difference to a steam trawler.

915. (*Mr. Crawford.*) I observe in your statement that you say that "The advantage or otherwise of prohibiting the landing and sale of under-sized sea fish: this, again, could be ascertained by trawling experiments, that is, by determining whether or no large and small fish are found on the same grounds, and the effect of different sized meshes in trawl and other nets, and also the effect of long and short drags on the vitality of fish." That points to the possible desirability of regulation of some of those points, does it not?—Yes.

916. Within the three-mile limit you have those powers, have you not?—Yes, but not of landing or sale.

917. No, at present not of landing or sale, but it would be in the power of the legislature to give you that power also of landing or sale, I presume?—I could not say that that would come in under the Act. You have power under the Act to close a certain ground or to prohibit either entirely or partially fishing subject to certain regulations, but I do not think there is any power to prevent any landing.

918. There is not at present; however, we may pass from that, because that was not exactly the point I was aiming at. But there is a necessity for regulations, and there is also the power of regulation to a large extent within the three-mile limit, is there not?—Yes.

919. Outside the three-mile limit the regulation might also be necessary, might it not?—Yes.

920. For example, you might desire, although outside the three-mile limit, to close certain areas against trawling, might you not?—Yes, at certain times of the year.

921. And you might also desire to extend the size of the mesh?—Yes.

922. Well, at present this country has no power to do that, has it?—No.

923. It could not prevent foreigners from defying those regulations?—No, not as regards foreigners.

924. Does not that point to the desirability of the co-operation with other Powers?—Yes, it does.

925. Is it not the case that however efficient a system of investigation around the British Isles we have—that would not secure the proper regulation of the sea outside the three-mile limit, would it, unless we got the co-operation of other Powers?—Not altogether—it would to a great extent in the Irish Sea.

926. I presume you are not very much annoyed with foreigners in the Irish Sea?—Not a great number.

927. But I want to ascertain from you whether you agree in thinking that that consideration rather points to an understanding with foreign Powers, because it is not in our power to make the requisite regulations beyond the three-mile limit unless we get the other Powers to join in it?—It does, but take, for instance, the nurseries off the Lancashire coast. Those nurseries are not wholly confined to the three-mile limit; they extend to a further distance outside that limit and require protection.

928. Supposing that foreigners took a fancy to come upon them, it is not in our power to eject them, is it?—No.

929. Not without an understanding with Foreign Powers?—No.

930. (*Mr. Spring-Rice.*) Have you got any figures to show the economical value in money, not in your land district, but in the sea district?—Do you mean the amount of fish landed?

931. Yes?—I have not here. The only figures that we get are those taken by the Board of Trade.

932. I should like to ask a question, too, about them. Would the Board of Trade figures give the value of the fish landed on the Lancashire and Western district fisheries—it is about a quarter of a million, is it not?—Yes.

933. How much of that represents fish caught away from the Irish Sea?—I could not give you an idea as to that. The only fish taken outside the Irish Sea is that taken by the steam trawlers, and they both fish inside and outside of it, and I could not give the amount taken outside. At the same time there is fish taken from the Irish Sea, for instance Cardigan Bay, by the trawlers from the south coast. They come round from Brixham, and land their fish at Milford.

934. I wanted to know whether you had any idea as to the value of the fisheries of the Irish Sea area?—I could not give you that. What I could say is, speaking, say, of soles, that the great majority of soles are taken from the Irish Sea, and not many from outside.

935. Do you think that much of the fish landed in your district, which is mainly at Fleetwood and Liverpool, comes from outside the Irish Sea?—A certain amount comes from the West of Scotland, taken by the steam trawlers, but the bulk comes from the Irish Sea.

936. On the other hand, do you think that the Brixham trawlers or Irish trawlers, or any Scotch boats take much out of that area?—I only know about the Brixham boats, but that is landed at Milford, and comes from the Irish Sea.

937. So that you have not been able to form an idea of the economic value of the fish in the Irish Sea?—No.

938. Professor Herdman has told us that the area of the Irish Sea, as he has dealt with it, is about 10,000 square miles. Now, I suppose a great deal of that is not area over which it would be possible to trawl?—A portion of it is not, but a great portion of it is trawled.

939. Have you any idea how much is trawlable; would it be half?—I have not measured it, but I should say it would.

940. I was speaking of the parts which Professor Herdman has discussed?—Nearly the whole of that is trawled.

941. That is a rather exceptional case, is it not?—Yes, it is a sandy and muddy bottom, and there are very few rocks about, except close to the shores. Take the Isle of Man, for instance. That between England and the Isle of Man is trawlable ground.

942. If you went northward towards Scotland you would get on a rocky ground?—Yes, but there is not much trawling north of the Isle of Man, along the Scottish coast, until you get to the Clyde.

943. Then on another point: as to the value of a distinction which is drawn between in-shore fisheries and fisheries outside the three-mile limit, have you got in your district a clear distinction in practice between those two—are they different branches of the business?—Yes, the in-shore fishing grounds are generally trawled by the in-shore boats, which are small boats, 8 or 9, or 10 tons. The outside district is fished principally by the deep sea trawlers. At the same time in certain parts of the district the deep sea boats come inside the district—I am speaking of the Lancashire coast. Then, again, if you go further south into Carnarvon and Cardigan Bays, you get the big trawlers fishing close in shore, in Carnarvon Bay, and off Newquay you get within the three-mile limit.

944. I notice that a good deal of the investigations of Professor Herdman is carried on in the three-mile limit.

(*Professor Herdman.*) Quite within it.

(*Witness.*) There is both shrimp and fish trawling there.

945. (*Mr. Spring-Rice.*) So that the distinction is not a very hard and fast one between in-shore fishing and other fishing except in the eye of the law. In practice, is it or is it not, a good distinction between in-shore and other fishing?—Yes, what we call the in-shore waters, those principally *there* (*pointing*), where you have the whole of the nurseries where the small fish are.

946. But the nurseries are for the benefit of the deeper fishing?—Yes.

947. So that you cannot look upon the in shore and off-shore as separate from that point of view?—No, one is dependent upon the other.

948. We understand that your district gives some technical instruction to fishermen?—Yes.

949. Is that done on a large scale at all?—They have several classes a year. The Technical Instruction Committee of the County of Lancashire give some funds towards that, and about four or five classes a year are held.

950. And they are held under the authority of the Sea Fishery Committee?—The Sea Fishery Committee does the work and provides the place, but the studies are really given under Mr. Herdman's direction.

951. Is the instruction valued?—I think it is.

952. Do you find plenty of people wanting to come?—Yes, in the winter time—in their leisure.

953. What do you instruct them in—in the mode of fishing with the steam trawler?—No, not as regards fishing, but as regards the fish itself, the food, and the spawning of the fish, and the size at which they spawn. Up to lately the fishermen along the coast had a very vague idea what the spawn of fish was. Many of them thought they found it on the sand and in little bays. That idea has been done away with owing to the instruction given to those fishermen. It has been proved to them without doubt that fish spawn away in the deep water, and not near the shores, but they come in when quite young, and go into the small estuaries to get out of the way of their enemies. The fishermen have got hold of that from the instruction given.

954. So that it is rather instruction in general knowledge about fishing than in any particular mode of fishing?—It is entirely about fish, not about fishing.

955. And that is valued?—Yes.

956. You do not carry it on yourself. Do you consider it a success yourself?—I do. I think there is very good proof that it has been a success along the coast of Lancashire.

957. (*Mr. Green.*) The investigations that you have been speaking of, I take it, are altogether with regard to trawl fish?—Yes.

958. Have you attempted anything as regards the decline of the herring fishing along the Isle of Man?—No.

959. Will it be possible to combine investigations of that matter with those other things that we have been speaking of?—It will, if the means for the staff were found by the State. I think that is a question they could take up very well.

Mr. R. A. Dawson.
24 Oct. 1901.

960. Do you think that trawling along the Isle of Man had anything to do with the diminution of the herring fishing?—I could not say that. It was thought when the steam trawlers came round to the west of England, and when it was seen the great amount of hake they took, that it would have bettered the herring fishing, but it does not appear to have made much difference.

961. It wants investigation as there are a great many theories about it; but you think that the same vessel could carry out investigations about the herrings?—Yes. Of course it is practically on the same ground that you make the other experiments.

962. Do you find on the ground that you are acquainted with that there are large seasonal changes; for instance, in the spring the fish are in one place, and in the autumn in another—do you find that is the case with the grounds with which you are acquainted?—Yes.

963. And the stock of fish clears out from some grounds for several months at a time?—They do. For instance, the sole will go further away from the coast when the temperature of the water becomes lower.

964. Though the greater part is periodically fishable is it not a fact that the haunts of the fish are limited and pretty well defined in the Irish Sea?—Yes, in the northern part they are fairly well defined.

965. But between the Isle of Man and Liverpool are they not?—Oh, yes, they are. But I do not know whether they are particularly defined in Cardigan Bay.

966. In planning a programme that has to be taken into consideration the monthly fishing that would be carried on would have to be arranged in view of the seasonal movements of the fish?—It would be an advantage to go over the same grounds at all seasons of the year.

967. Season or no season?—Yes.

968. Have you any reason to think that soles migrate into that part of the Irish Sea from outside, or do you think that the stock belongs to the Irish Sea?—I think it belongs to that area, we have the spawning grounds, and the nurseries for the young soles, and the fish themselves; and they come for spawning purposes on different grounds from where you find them at other times of the year.

969. Of course you cannot say that about the hake?—No, we have very few hake off the Lancashire coast.

970. But the same applies to a certain extent about plaice?—Yes, as regards nurseries and spawning grounds.

971. The plaice, more or less, belong to that area?—They do. I cannot say whether the whole of the plaice that we get in the Irish Sea are spawned in the Irish Sea, but no doubt a quantity of them are. But with soles it is more certain about them.

972. Would not the movements of fish decided upon in the North Sea only indirectly help you in saying what state of affairs was going on in the Irish Sea?—I could not say that.

973. The migration of them?—I could not say that.

974. If you wish to know the actual movements of fish in the Irish Sea you would have to investigate it for itself?—I should think so.

975. No matter how much was done in the North Sea?—Of course the experience gained in the North Sea would be very valuable, but you want to have the work carried out in the Irish Sea to ascertain it.

976. And similarly all round the coast; each case has its own peculiarities?—To a certain extent they would have, especially as regards the food and the seasons for migration.

977. (*Professor Herdman.*) I think you stated in answer to a question that you think it would be an advantage to have a separate department for England, apart from Scotland and Ireland?—I thought so.

978. Are the fishery interests of the three countries to some extent distinct, or do you think they are identical?—I think they are distinct. For instance, you take Scotland, as far as I understand, they have few sole grounds off the Scottish coast. Here in the Irish Sea we have the big sole fishery.

979. Do you think it would be better that fisheries investigation should be under such a central department for England rather than it should be connected with the district committees?—I think so.

980. Can you give us any reasons why?—I think if it is left altogether to district committees, there would be too much local influence used. You would be asked by one body to do the work in one place and by another in another place—I think it interferes with the work.

981. Do you think that any combination is possible of work under district committees with control from a central authority, or do you think the district committees should be entirely freed from scientific work?—I think it would be better worked by a central body.

982. You do not think there is any necessary connection between scientific work and the administrative work, or do you think that they help one another, and should go together?—I think it is better separate. But as regards the carrying it out there is no harm in having the assistance and knowledge of the administrative departments.

983. Do you think that the whole time of one steamer would be required in order to investigate adequately this northern area of the Irish Sea?—I do. The reason I say that is that before the Lancashire district was extended, that is before the amalgamation of the two districts took place, we tried for several years to do the police work and scientific work with one steamer, and we found that it could not be done, and that it would take the whole of the time of two steamers. You cannot do the two things with one vessel.

984. It cannot do both administrative work and scientific work?—No, one interferes with the other.

985. (*Mr. Archer.*) Would you tell us by whom the observations on board the Lancashire Committee steamer have been carried out?—They have been carried out by myself and the crew, with occasional visits by one or the other of the assistant scientists.

986. I suppose you are not always on board?—No.

987. And when you were not on board who carried them out?—It was carried out by the captain and crew of the vessel.

988. Are you satisfied with the way in which he has carried them out?—Yes, I am satisfied in this way, that although they are not regularly done; those that have been done are as correct as they could be.

989. But you are satisfied with the way in which he has counted the fish, and the observations which he has taken with regard to temperature?—Yes.

990. And the specific gravity of the water?—Yes.

991. And the collections of Plankton?—Yes, I often go to re-count a certain number myself, and especially with the large quantities of small fish that are taken by the shrimp trawls. I have been very particular to see that the way that they get out the number is as correct as it possibly can be got.

992. When you catch a very large number of fish, do you count each fish separately?—No. When the fish are very small we take a measure, and every third or fourth measure is counted, and I find out by experience that the average comes out fairly accurate.

993. What is done with the tow netting collections?—They are put in spirit, and are forwarded to Mr. Ascroft and then he sends them to the laboratory at Liverpool or Piel.

994. They are collected on the steamer, and worked out at the laboratory on shore?—Yes.

995. Did the information which is obtained by this means throw light on such things as nurseries and spawning grounds?—Yes.

996. Do you think that skippers of trawlers could be trained to take similar observations?—I do, but the question would come in there that it would take up a considerable portion of their time. If they undertook to go through the same work as is done on board the Lancashire steamer when we are taking these statistics it would take a certain amount of their time in counting these fish.

997. But they have a considerable amount of time, have they not, between one trawl and another?—Not as much as you would think. The time of hands on a steam trawler is taken up in gutting the fish and getting them packed away.

998. But still in getting the fish packed away they would be able to ascertain the quantity and description of fish that they have caught?—If you are speaking of larger fish on the trawling grounds, they count the number of boxes of certain species of fish that they take, and it is very little trouble to get at the quantity as the boxes are very much of the same size, and hold about the same number.

999. Obviously a very great saving would be effected in collecting information, if such a plan as that could be worked?—Yes, if forms were given to them to fill up, in that case I do not see that it would be much trouble, because they have to give a return of the number of fish landed now.

1000. Do you know how near you can get to a given point in the sea on dark stormy nights or thick weather, or when no observations of the sun or stars can be made?—That would depend upon what the special point is. Are you speaking about trawling stations?

1001. I am rather referring to trawling stations out of sight of land?—Yes, you get there. The fishermen have to do it now. For instance, a sailing trawler coming out of Fleetwood, the weather may be thick or hazy; the skipper will run a certain course, and he judges the vessel's speed, then he will heave the boat to and sound, and judge by the depth of the water and what sticks to his lead whether he is on the ground. Occasionally they take half-a-dozen different soundings before they let go the net, that is, when they come upon the particular class of sand or mud where they want to fish; and in the thickest weather they get to pretty much the same place.

1002. Could they get within a mile or a couple of miles of the same point?—Yes.

1003. (*Professor Thomson.*) Why do you think that the international scheme of investigating the North Sea has little connection with British fisheries?—The reason I made that remark was in looking at the map that was drawn as a field for operations at Christiania and Stockholm, it appears to me to leave out a great deal of what we call the British fisheries.

1004. Have we not got a great stake in the North Sea?—Certainly, and as regard that it is very valuable, but I was speaking more of the fisheries near home. *Mr. R. A. Dawson.* 24 Oct. 1901.

1005. Still you say that has little connection. Now we have more at stake in the North Sea than anybody else?—Yes, but you would not call it entirely British fisheries, whereas the Irish Sea is practically entirely British.

1006. It seemed to me that your sentence was very strong—to the effect that the Irish Sea furnishes more material than the North Sea?—Not in quantity of fish, but in the compactness of the ground, and having the spawning grounds and fisheries and nurseries, and shrimping industry all near one another.

1007. Still that is hardly more material?—It is a better field for operations.

1008. (*Mr. Green.*) You have had a good deal of experience with the steam trawler skippers?—Yes.

1009. Their educational condition is not very high?—No, it is not.

1010. Do you think one in ten would be reliable to make observations of scientific value?—They would be reliable if there was not too much detail about the work. I mean to say if you only want to get the number of fish taken, and upon which ground it was taken, it would be reliable as far as that goes, but I do not think it would be reliable as regards scientific research.

1011. (*Mr. Archer.*) Are you referring to the east coast or the west coast?—The west coast not the east coast.

FOURTH DAY.

Tuesday, 3rd December, 1901.

PRESENT:

The Right Hon. Sir HERBERT MAXWELL, Bart., M.P. (*Chairman*).

WALTER E. ARCHER, Esq.
DONALD CRAWFORD, Esq.
The Rev. WILLIAM SPOTSWOOD GREEN.
Professor WILLIAM ABBOTT HERDMAN, F.R.S.
The Hon. THOMAS H. W. PELHAM.
STEPHEN E. SPRING-RICE, Esq., C.B.
Professor J. ARTHUR THOMSON.

R. E. MARTYR, Esq., *Secretary*.

Professor D'ARCY WENTWORTH THOMPSON, C.B., called; and Examined.

1012. (*Chairman.*) You are Professor of Natural History at University College, Dundee?—Yes.

1013. And a Companion of the Bath?—Yes.

1014. And you are a member of the Fishery Board for Scotland?—Yes.

1015. You will be able to give us a synthetic view, therefore, of the work of the Fishery Board?—I trust so.

1016. Will you tell us anything that will give me a clear idea of the scope of the work and its subdivision?—The scientific work done under the Scottish Fishery Board may, I think, be grouped under three heads. We have, firstly, the experimental and statistical work concerning the abundance, distribution, migration, rate of growth, and so forth, of the food fishes. We have, secondly, certain experimental work on the hatching and liberation of young food fishes. And, thirdly, we do a considerable number of zoological and anatomical studies more or less connected with fishery questions, but not entirely with a practical object.

1017. This work has been carried on for how many years?—The whole work of the Fishery Board, do you mean?

1018. The scientific work?—The scientific work has been carried on now for about 19 years.

1019. Including hatcheries?—For nearly all of that period. And, if you will allow me to say so in regard to this last or third section that I have described of our work, it is carried on at small expense, and it merely involves the utilisation of materials gathered in the course of the more practical and statistical work that would otherwise be lost. It is work whose value, I think, is recognised, but we do not put it in the forefront as an essential part of our Board's duties. If you would care for me to describe to you in any greater detail the actual work done I shall be glad to do so. *Prof. D'Arcy Thompson.* 3 Dec. 1901.

1020. I should imagine that the Committee are fairly familiar with the nature of the work done from the annual reports. I daresay some member of the Committee will be inclined to ask you some question upon that. For my own part I am satisfied with the Annual Report. We will go now to the experimental part of your work. What have you to say to that?—Do you ask me to describe the experimental work?

1021. Yes?—The experimental work—the work done under my first head—consists in the first place of systematic trawlings that we make by the aid of the little steamboat, the "Garland," supplemented within the last two years by work done on board commercial trawlers. The object of these investigations was, in the first instance, the great main question as to whether on certain specified areas we can trace diminution or no diminution of the fish supply. And that is precisely the work that is prominent in the programme of the new International Conference. But I should like to say, in the forefront of my evidence, that while those experiments have been carried on for many years on board the "Garland," and carried on in good faith and in the belief that they would be useful, it has gradually been borne in upon us that this ship is entirely inadequate for the purpose, and that the results she has produced during many years are of no value—I say it without hesitation—of no value for the comparisons that they were designed for.

Prof. D'Arcy Thompson.

13 Dec. 1901.

1022. You have attained certain results by means of the "Garland," have you not?—We have attained certain results, and we have based large deductions upon them.

1023. Erroneously, as you suppose?—I will not say erroneously. We have done it to the best of our ability, and in the hope that, so far as they went, they would be useful. But it is now absolutely clear to us, and especially from the work on board the larger commercial trawlers within the last two years, that the data are inadequate for proper deductions to be drawn from them.

1024. Can you give us an illustration of the kind of thing?—Apart from the fact that the "Garland" is too small and too unseaworthy to be used in the outer waters in the winter season, or, in short, whensoever the experiments are desired, the gear that she is able to use is so small as not to be comparable with that which the fishing vessels, the commercial trawlers, use, and the following illustrations will give you an idea of the very small numbers with which it enables us to deal. In the year 1900 the "Garland" captured in her whole year's work 1,152 plaice in the Moray Firth, or an average of 16 in each haul, while an Aberdeen trawler, with Dr. Fulton on board, captured in two days 12,911 plaice, an average of 1,434 to a haul; or, deducting two short and imperfect trawls in this latter case, an average of 1,740 to a haul, more than half as much again as the result of the "Garland's" whole year's work. I am inclined to think that from experiments on such a scale as this last, repeated with due frequency, we should be justified in drawing statistical conclusions; but from catches such as those of the "Garland," where the average take of cod was two and of whiting under three, we are not entitled to do so.

1025. Can you rely upon the reports of the trawlers?—In this case either Dr. Fulton or an assistant under the Board was on board.

1026. It was very rough work, was it not?—Very rough work indeed. In regard to the use of trawlers, I am prepared to give evidence as to the advantages or disadvantages of hiring trawlers as compared with the employment of a specially equipped ship. But I could also illustrate the advantage of these last experiments of Dr. Fulton's on board the hired trawlers in another way, by pointing to certain results that he obtained in the latter part of 1900 by the short experiments that he then made. Dr. Fulton was then enabled not only to count the catches in the manner I have described from the successive hauls, but by adding on behind the ordinary trawl net a smaller mesh net he made in a very few days certain exceedingly important experiments. He found, for instance, that the proportion of food fishes so small as to be unmarkstable, captured in the ordinary trawl net, was for the most part very small—much smaller than we had anticipated, averaging in the course of these experiments less than one per cent. in the case of ling, torsk, and hake, one-half per cent. in the case of haddock, and 11 per cent. in the case of cod.

1027. (*Mr. Pelham.*) Percentage of what?—Of the total catch.

1028. (*Chairman.*) I do not quite understand what you mean by total catch. Supposing there were 150 mature plaice in the trawl, there would also be a percentage of immature ones, would there not?—Yes, such a percentage as I have described of immature ones; but at the same time, and on the other hand, he found that in certain particular cases and in particular localities, this proportion of undersized fish was much greater, rising to 65 per cent. in the case of whitings in certain particular inshore waters.

1029. Again I do not quite understand. He arrived at this conclusion by means of the small mesh net behind the trawl?—I am afraid I have explained myself imperfectly. This particular fact would have been discovered without the small mesh net.

1030. Quite so?—He also found by the use of the small mesh net that vast numbers of undersized fishes passed through the ordinary trawl net, many times as many as are caught therein, and that the vast majority of these passed through alive and uninjured. But on the other hand, that while this holds good of the round fishes, and even to some extent to the narrower bodied flat fishes, it is not so with the plaice, of which very few indeed (about ·4 per cent., and those of very small size, not above 4½ inches in length), passed through the ordinary trawl net into the small mesh net in the manner I have described. In other words, the ordinary trawl net is a very dangerous engine for the young, undersized flat fishes, and is not so, or is so to a very much smaller degree, in the case of the round fishes. Thirdly, he experimented on the size of mesh, and found that a mesh of larger size than that usually used—the usual mesh being 1½ inches—would be for most fish impracticable, owing to the immensely increased proportion escaping, a net of 2 inches retaining only 7, and one of 2½ inches mesh only 3 per cent. of the total number of fishes that entered it; the latter, the 2½ inch mesh, he found retained only one out of 8,551 whitings that passed through and were retained in the small mesh net. But again, on the other hand, he found that the 2½ inch mesh was an efficient instrument for the capture of plaice, of which the largest that passed through it was about 9¾ inches in length, that is to say, approximately the size that we usually look upon as a proper size limit for plaice.

1031. You are not going into the abstract question of the injury by trawlers, are you?—Not at all. I am merely giving you this in the hope that it may illustrate the valuable work that may be done in a short time by the use of an efficient ship, and that had not been and could not have been done in all the years we have employed a little vessel.

1032. You could not use the small mesh net in the "Garland," could you?—We can use the small mesh net, and do so every year, but the net which the "Garland" uses is only about 20 to 25 feet in beam.

1033. (*Mr. Pelham.*) The trawl net?—The trawl net; and it is what is called a beam trawl, while those commercial trawlers were using the much more efficient engine of the otter-trawl, and using it with a span of 100 to 120 feet.

1034. (*Chairman.*) Then, in your opinion, the "Garland" is a costly and inefficient instrument?—Yes, entirely inefficient in my opinion for the greater portion of the work we have to do.

1035. Passing now to the larger question of international co-operation, no doubt you have given consideration to that problem; what have you to say?—I have attended on behalf of the Government the two Conferences held at Stockholm and Christiania.

1036. Have you anything to tell us on that head?—The ultimate aim of the Stockholm and Christiania programme is simply to settle the question whether the North Sea is being over-fished, and to determine to what extent, and under what safeguards, it can be fished to the most profit and advantage. Precisely such experiments as those of Dr. Fulton's are part of the programme; but it is of the essence of the scheme that experiments shall be simultaneously conducted in various parts of the North Sea, and shall be periodically repeated over a term of years; and further that they shall be accompanied by accurate meteorological and hydrographical observations in order to determine the physical conditions that guide the migrations; or affect the abundance of the fish; and it is also an essential part of the scheme that the apparatus used should be standardised, the methods of work directed, and the assistants instructed in a central laboratory, and the results checked and co-ordinated by the Central International Bureau.

1037. The independent observations of professional trawlers unaccompanied by any scientific supervision would not be of much use, would it?—It would be of very little use, although on the other hand it is noted in the Stockholm programme that we shall use all the information that they can give us; that we shall collate the statistics of the fish market, the statistics of the trade, and take cognisance of all such information.

1038. Yes, but you could not expect a commercial trawler to undertake these minute investigations?—By no means; it would be absolutely impossible. Moreover it is plain that for any one nation to withhold concurrence, to refuse participation in this scheme of work, would be to destroy its value, or to throw upon the other nations the task of investigating its waters.

1039. What do you estimate the relative interest of Great Britain in the North Sea compared with those other countries?—I am unable to make a direct comparison.

1040. It is a considerable one, is it not?—It is very great indeed. We have at present the greatest interest in the North Sea, but if we were to deal in detail with

the interests of nations in the North Sea we should be immensely struck with the increase of that interest in the case of certain nations, and especially in the case of Germany, whose interest in the fisheries has increased enormously.

1041. Is it subsidised?—I am unable to give details. It is encouraged in various ways.

1042. Then I understand that you are convinced of the desirability of co-operation?—Absolutely convinced. If you will permit me I will illustrate that by another particular case. It is the duty of the Scottish Fishery Board, not only to undertake general investigations, but to undertake from time to time specific investigations, where complaints of fishermen or other local conditions require attention. For example, we have been lately dealing with a petition from certain fishermen on the west coast for the closure of certain herring fisheries by means of seine nets on the banks of Ballantrae, in Ayrshire.

1043. Have you not issued an order about that?—I do not think that it is promulgated. I think that it is in the hands of the Secretary of State for Scotland.

1044. (*Mr. Crawford.*) It is sent up for approval? Yes. We accordingly asked Dr. Fulton to go down and investigate this matter. But we have no statistics, we have no knowledge, as to any physical conditions that might, independent of man's action, have caused the fluctuation, or have brought about such a diminution as reported to us of the herring fishery on this coast. Now, I have here in my hand an extremely interesting publication of the Swedish Hydrographical Department by Otto Petersen and Ekman, in which they detail the results of their studies over several years upon the characters of the different areas or masses of water in the North Sea, and especially those entering the Skagerrack and Kattegat; and they are able to show here how the diminution of the herring fishery in those waters within the last two or three years has been directly coincident with abnormalities and changes in the character of the sea-water, and in all probability to the deflection of certain great currents from the north. I do not trouble you with details of this matter, but you have here a series of maps issued by those gentlemen in which they illustrate the different characters at different seasons for several years of the water in the North Sea, its differences of temperature, of salinity, and of the floating organisms that it contains, with the view of showing, and I think to a great extent showing effectively, how the herring follows certain masses of incoming water, and when these are deflected the herring does not appear on the coast where it formerly came, and we find it somewhere else. These are very important investigations, and these are part of the investigations that were undertaken on private initiative before the International Conference was determined on, and that led His Majesty the King of Sweden to use his great influence to bring it together.

1045. (*Chairman.*) So much for the desirability of international co-operation. Have you formed any estimate of its practicability?—From what I have seen at the two conferences of Stockholm and Christiania I should say that there is no difficulty at all, except the comparatively small cost; especially at the last Conference the members from the various countries worked easily and harmoniously together, and the programme, the detailed programme of researches, was elaborated with full agreement among all the members.

1046. Does there exist at present any co-operation between the three kingdoms, England, Scotland, and Ireland, in fishery matters?—In regard to scientific fishery matters there exists none.

1047. There exists none?—None whatever.

1048. Before entering upon a larger scheme of international co-operation, is it desirable or necessary, in your opinion, that there should be some close relation established in our three kingdoms?—I am not inclined to think that it would do very much good, at any rate without the larger international co-operation. I am inclined to think that no local investigation of our own waters would lead us to very important or adequate deductions without a simultaneous investigation of the more distant seas.

1049. Are you conscious of any disadvantage in the present absence of any relations between the three bodies of the United Kingdom—does it interfere with your scientific work in the Scottish Fishery Board not to be in correspondence or correlation with the English Department?—I could hardly assert that unless I thought that the particular work which we are doing was more than it is of a nature requiring to be co-ordinated. As soon as we embark upon these larger researches then co-ordination will be necessary, but the more local work that we have been doing we can do very well so far as it is effected by ourselves without co-ordination. There is no objection at all to co-ordination, but I do not think that there has been in the past an urgent necessity for it.

1050. Well, then, I shall ask you a further question which you must use your discretion in answering, namely, whether you have formed any opinion as to the expediency of a Central Board for the whole of the United Kingdom, a Central Department, or whether you think the present division into three is preferable?—Well, Sir, I have thought this matter over with the very greatest care, and it seems to me exceedingly difficult to give a categorical reply; but on the whole I am inclined to think that the present system is the better. Firstly, because we have a going concern that there is no necessity for disturbing; secondly, because any scientific fishery administration that we may have will have, as I have already described, to do special local work, as for example, those investigations at Ballantrae; or take the case of a recent report on the clam shell fisheries in the Firth of Forth, and others of a like kind, where the Fishery Board for the purpose of legislation requires definite and prompt information. There is, in short, part of the work of the Scientific Department that is essentially associated with the work of the central authority that presides over fishery matters. And, thirdly, our administrations are so extended that I think we should in all cases require specialisation of work for its different parts, separate bases for the different coasts, separate vessels and separate staffs for the northern and southern and Irish coasts and so forth. I do not profess to say to what extent such division would need to be carried, but I see clearly that the whole could not be worked from a single base.

1051. With reference to the Ballantrae case, are you in a position on the Scottish Fishery Board to push your inquiries, say, to the North Coast of Ireland, at the present time?—No, we are not.

1052. Do you not think you would approach that inquiry at Ballantrae with greater freedom if you were in a position to do so?—I do not think even to do so would be efficient for the fluctuations and migrations of a fish like the herring. We want information over a far wider area than that. We want precisely the information that this international programme is designed to give us over a wide area of the North Atlantic.

1053. In short, you are no advocate for further centralisation?—On the whole, I am not.

1054. I think you have got something to tell us about the cost of the fishary establishments in some of the countries?—May I say, with regard to the extension of work, that the Danes, for example, hope to extend their investigation not only to the Faroe Islands but even to Greenland, as showing their opinion of the need for information over a wider area; and although the Stockholm Conference was only called with regard to investigations within the area of the North Sea, that is to say, involving our eastern coasts, the opinion was repeatedly expressed there that it was in the highest degree necessary that investigations of the Channel, of our Western Coast, the Irish Coast, in short, of as much as possible of the Atlantic area, should be added to the rest of the programme; and in regard to our English Channel I think no one can doubt for a moment that its simultaneous investigation was bound to come to be an essential part of the general programme. We have to deal there with a new body of Atlantic water entering into the North Sea, affecting the southern portions of the North Sea, affecting the great flat fishery, and so on. These are reasons for which it is essential that that area should be investigated.

1055. (*Mr. Spring-Rice.*) In regard to this Christiania programme, in which you have taken a large share, may I ask are you satisfied that it is so designed as to give sufficient prominence to the particular problems which most concern this country, Great Britain? Perhaps I may explain that I inferred that you thought, as everybody else did, that the great problem is the flat fish, and I ask whether in your opinion the Christiania programme gave sufficient prominence to that?—I beg your pardon, I did not say that the great problem for us is the flat fish.

1056. I will not put words into your mouth. But

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supposing for a moment that we are more interested in the plaice fishery than the cod fishery, for instance; are you satisfied that the Christiania programme is so designed as to give sufficient prominence to the problems in which Great Britain is interested as compared with the problems in which Germany and Scandinavia are interested?—I cannot admit that one species of fish concerns us more than another. I am not sufficiently familiar with the statistics—the conditions of different parts of the coast are too different. If it were in the case of Denmark, I should say without a moment's hesitation that the plaice fishery was by far the most important. But I do not think that anything I have said bears upon that distinction. If I may answer your question in general terms I would say that I am quite ready to admit that in the preparation of such a programme as this there must be a good deal of give and take. There are a number of researches that are of more interest to one country or even to one scientific director than to another, but I am perfectly confident that on the whole this programme is a useful and a practical one, and that it will give us in the end the information that we desire.

1057. Do you think it is as well designed to give the information whatever it may be that is required for Great Britain as the information that is required for Germany?—Quite so.

1058. I will not discuss with you whether we have special interests or not. You say you have not looked at the statistics?—It is plain that the interests on the South-Eastern coast of England differ somewhat from ours in Scotland. It does not seem to come within my province to ascertain precisely which fishery is most important or lucrative—there are many of them so great.

1059. I may perhaps put it in another way: taking our great trawl fisheries carried on from Aberdeen and Grimsby and Hull, which you are probably aware is the largest in money value of all the British fisheries, do you think that this Christiania programme is so designed as to give the information which is most needed for that branch of our fisheries?—I do. It gives a great deal more, but it will be found to give the essential facts that we require.

1060. Does it give them the prominence which you think that they deserve?—I might admit that it is not precisely drafted as we should have drafted it ourselves, but I think, considering the number of countries interested, that in the aggregate the programme is as good as we could expect.

1061. Do you think that you have made the best bargain that the circumstances would allow?—I do.

1062. (*Chairman.*) To revert to this question of area for a moment. Have you not found a difficulty in the delimitation of areas between separate authorities, within our territorial waters I mean?—Owing to the want of co-operation between the three kingdoms, do you mean?

1063. Yes?—I do not think so. We have found some recent questions in the Solway Firth to have been solved in a very simple and easy manner. We have found none, so far as I know, on the scientific side.

1064-5. None on the scientific side?—None.

1066. You were going to tell us, I think, some particulars of certain portions of foreign scientific statistics?—I can give you some facts as to certain foreign scientific establishments. Norway already possesses a suitable ship, the "Michael Sars," capable of long voyages. I am not able at this moment to give you her exact cost. It was somewhere about £12,000, but she is described in full detail in Petterman's Mittheilungen in the earlier part of last year. Her annual maintenance in 1901 cost £2,975; the estimate for 1902 is £2,808, of which about £1,300 is for coal; the director, Dr. Hjort, receives £270. Travelling expenses and assistance in hydrographic and botanical work cost in 1901 £225, and for next year the estimate is about £500. Furthermore, Norway, besides making the ordinary contribution to the Central Bureau, will contribute a considerable sum, not yet fixed, to the expense of the Central Laboratory, which is to be situated in Christiania under the direction of Dr. Nansen. The sum of £280 is also included in the estimates for the year 1902 for costs of publication. The total cost to Norway is, according to the estimate, £3,850, not including her contributions to the Central Bureau and Laboratory; including these expenses, it will exceed £5,000 a year. I have here a Parliamentary paper giving these facts. Denmark possesses a scientific department under the charge of Dr. C. J. Cs. Petersen. The department has at present no ship, save one only, fitted for work in the inshore waters, but investigations of the deeper waters of the Skagerrack and Kattegat have been made with Government vessels and hired tugs. A trawler of the largest size is about to be purchased at an estimated cost of £7,370; her complete scientific outfit is estimated to cost £3,969—in all, £11,339. Her annual expenses are estimated at £4,272, and other expenses of staff, laboratory, and so forth, at £2,268. In all, the annual budget is £6,540, plus an initial capital expenditure of £11,339. I may point out that the Danes have to deal in the first place with very deep water in their own immediate neighbourhood—over 300 fathoms in the Skagerrack, and, further, that they contemplate extending their periodic researches to the Faroe Islands and to Greenland. Dr Petersen has already issued nine volumes of annual reports, and even with the narrow equipment that he has had those are of great importance and excellence. In Holland the Dutch already possess a laboratory at the Helder, under the charge of Dr. Hoek, who is nominated general secretary of the International Central Bureau. This laboratory at the Helder is the property of the Netherlands Zoological Society, from which the Government rents four rooms at £70 a year, adding £125 of annual subsidy to the Society. A new wing is now being built, and a house of eight rooms, the property of the Government, is at present in use as a succursale. For the equipment of the new laboratory £666 is now in hand, and a further annual expenditure of £100 is estimated. The other expenses are: Director's salary £375, three assistants at £208, £150 (hydrographical), and £100; three servants at £70, £50, and £40; gas, water, coal, travelling expenses, etc., £250. The Dutch Government do not contemplate building a special ship for the proposed researches, but will use a hired tug at an estimated cost of £17 to £20 for 70 days in the year—say £1,400. If I may say so, I think that this is a method of work which is feasible in the case of Holland by reason of her small extent of coast line and the absence of any deep water within the area that falls to her to investigate. Dr. Hoek does not approve of an ordinary steam trawler for purposes of research, preferring a large tug. The new expenditure contemplated by the Dutch Government thus amounts to about £3,000 a year, apart from the contribution payable to the Central Bureau. Dr. Boek explains that the cost is kept within these limits owing to the fact of a very considerable equipment of apparatus being already in the possession of the laboratory. I am sorry that I cannot give you similar figures in regard to the Germans as yet. A letter has miscarried which ought to have arrived before now, but I am promised it by this evening or to-morrow morning.

1067. Perhaps you will hand it in. You will be able to give us the information later, I suppose?—I could give you the information to-morrow in five minutes.

1068. Is it official information?—It is official information from the secretary.

1069. Will you refresh my memory by telling me what is the annual scientific Vote for the Scottish Fishery Board?—Including the superintendent's salary, £3,120, of which the annual maintenance of the "Garland" costs £1,150. The total sum includes the maintenance of the hatchery, which is not included in the work of other departments I have spoken of.

1070. (*Mr. Crawford.*) With regard to the question of co-operation in the United Kingdom, there is a separate fishery board in Scotland, and there is one in Ireland, but is there one in England?—There is not. But even if there were, even if we had in England an official scientific fishery department as we have in Ireland, and as we have in Scotland—I think even then it would require a very strong case to be made out before we should interrupt their special work and unify them under a new board. I am not able to see what real essential differences it would make except, perhaps, the appointment of a single individual director over them all.

1071. Do you think it desirable that the present system in Scotland by which the administration of the salmon fisheries is under the same board as that of the sea fisheries—do you not think that that is a desirable thing?—I think, on the whole, that it works well.

1072. And, assuming that the scientific part of sea fisheries were withdrawn from the Scottish Fishery Board, might it not be a totally different question whether the salmon fisheries should be withdrawn?—That is certainly so. But I should like to repeat that I am not urging any strong objection to the existence of a Central Marine Survey in England. I only fail to see any positive advantages that would be obtained from it, especially when we bear in mind that we have a going

concern in Scotland, and when we further bear in mind that the particular programme of international research is not to last for ever, but that its main results will be before us in a period of five years.

1073. I thank you have made that clear. Pursuing the same subject a little further, you said that the Scottish Fishery Board, in investigating such a question as the use of the seine at Ballantrae, would not be in a position to push their inquiries on to the coast of Ireland. I understand you did not mean by that that there would be any objection to their doing so?—I meant merely that the means at our disposal are not adequate.

1074. There would be, and there is at present, no delimitation in the sense that it would prevent any fishery authority in the kingdom making scientific researches all round the coast?—Not in the least; and I am further prepared to admit that when this full programme comes to be worked out, the question of delimitation may be somewhat difficult, and may not coincide necessarily with the limits of the three kingdoms. I am quite prepared to admit that the work on the Eastern coast of Scotland might be found very closely linked with that on the Northern part of the East coast of England, more so than the Northern part of England is linked with the Channel and the South-east corner.

1075. Supposing we had three authorities for the three kingdoms, would you recommend and would you desire that it should be, if necessary, imposed upon them that they were to work harmoniously, and upon a harmonious plan?—Most certainly, and I should think that would be insured by the control of the International Bureau. I have come to this general opinion with great difficulty and after a great deal of consideration. I simply am not convinced yet of any arguments of weight strong enough to break up the existing organisations and to form a new central survey.

1076. I suppose, in fact I understand you have already said that the work in the most important part of the scientific research which apparently ought to be of most utility has hitherto been disappointing in the Scottish Fishery Board, but the reason is that we have not a vessel?—That is the fact, and the whole reason.

1077. (*Chairman.*) Assuming the existence of three international departments, independent, even if under control of a central bureau, would there, in your opinion, be no risk of overlapping—a waste of work?—I do not think so. I think the difficulty would be to overtake it all.

1078. But that does not safeguard us against overlapping. You spoke of the East coast of Scotland and the North of England as being practically one district?—I was merely taking that as an illustration of possible need for mutual arrangement.

1079. A very obvious illustration, I think?—The question of delimitation is one not only as between various parts of our own country, but as between the various countries concerned in the international investigation, and for that reason it has been left to the Central Council, which has not yet met, to reconsider it with greater care than was done at the preliminary meetings.

1080. (*Mr. Pelham.*) I understood you to say that the great object, the whole object, in fact, of the Hydrographical Conference was to test the population of the North Sea; that is an interpretation?—That is an interpretation.

1081. Or whether the North Sea is over-fished?—That is simply an interpretation of the ultimate object of the whole.

1082. Would that really apply principally to flat fish?—No, that would have a much wider scope; that would include the cod and haddock fishery, and any others.

1083. Would it relate to migratory fishes, like the herring or mackerel?—It would, most certainly.

1084. It would not be so easy to test by experiments whether the supply was increasing or decreasing?—No, but in regard to the local fluctuations, I have already tried to illustrate how extremely important these international investigations are.

1085. Even as regards the herring?—Particularly important there. We know that the herrings now and then desert a certain coast for long periods, and again come back, and these hydrographical researches are most expressly designed and intended to determine the cause and the manner of such fluctuations.

1086. I understand that you would make considerable use of what I may call trade statistics?—Yes, we should do so.

1087. You would not only have your experiments by special boats, and your experiments possibly by skilled men on board trawlers, but you would take trade returns for the year as given in particular ports?—Most certainly, and with regard to that, so far as I know, in Geestemünde the Germans have trade statistics of a more detailed kind than we have. For instance, at Christiania, President Hervig, the German delegate, was able to obtain immediate telegraphic information as to the total catch of German trawlers during last year within the area of the Moray Firth.

1088. Would the work conducted by the special boats be guided to some extent by the trade statistics?—I do not think so. I think when first particular lines and stations of observation were chosen for purposes of comparison during five years under the programme, we should have to continue those. We might, of course, make many other special investigations.

1089. Supposing it was shown from trade statistics that the returns of fish from a particular part of the North Sea were diminishing or increasing would you make special investigations there by your special boat?—I think most certainly we should, and I think, moreover, that the programme laid down at these periodic investigations at particular stations should leave our ships ample time for such special investigations. Such investigations as you suggest would probably come under the head of special local investigations, apart from the general international programme.

1090. I suppose the difficulty would rather be, although you might make investigations after the trade returns, you would not be able to trace how the variation takes place, because you would not know what the hydrographic conditions were, perhaps, three or four years ago?—In regard to the past, our knowledge of the hydrographic conditions is not what it should be, although we have a good deal of scattered information, but with regard to the future the whole object of this programme is to give us a survey of the whole area.

1091. I am afraid I did not make myself clear. Supposing in three years' time you discovered from the trade returns that there had been a great change in those three years—after this date—though you might send a special boat to investigate what the condition of the bottom of the sea was in that particular bank, you would not have anything more than the trade statistics for the three years previous?—I do not think so, for this reason, that the hydrographic conditions in the different parts of the area can be ascertained over the whole area by the examination of a sufficient number of points.

1092. I see. I want to ask you a few questions about the "Garland." Those investigations were made at nine stations in the Firth of Forth?—And fourteen in the Moray Firth.

1093. Take the Firth of Forth; those were checked under your supervision?—Not immediate direct supervision.

1094. But you know the results?—I know them in general.

1095. And did you not get any reliable data for the Firth of Forth in itself?—I think if you will forgive me saying so, that for precisely detailed information with regard to these experiments, Dr. Fulton would be a very much better witness, as he has conducted all those researches for many years, while I have only comparatively lately come upon the Board after the experiments were instituted. I have given you briefly and somewhat strongly my opinion as regards the general apparent inadequacy of those researches—the obvious inadequacy of the numbers with which they deal for determining the general averages required.

1096. May I ask you generally, do you think that a sample taken by one trawler on a particular line would be a test of what the conditions of the supply are on each side of that line?—The trawler makes many hauls in a day. The sweep of the net is very great; she covers a great area. In the case of the "Garland," with her little trawl, if she catches no cod we can say nothing, but when a trawler with a net of 120 feet diameter catches no cod you are pretty sure there is none there.

1097. But the relative size of the "Garland" to the area in the Firth of Forth would be almost as large as the biggest trawler used in the North Sea to that area,

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would it not?—The proportion would be different with regard to the movements and chances of escape of the fish.

1098. How often would you make these experimental trawls, say, in the North Sea on one particular bank; how often would the trawling be repeated?—Over three or four times a year.

1099. How long at a time—one day?—I should say the ship would probably make several hauls of about three hours each.

1100. Parallel to each other?—Yes, or near one another.

1101. But all in one day?—Yes.

1102. Four times a year. You think that that sample would be sufficient to give you an idea of the condition of that bank for the whole year?—I think that three or four periodic observations in the course of the year is as much as we can expect and ask for, and that it would give us over a term of years adequate information.

1103. How many years would it take before you would finish the work?—Five years is the general opinion of the men who met at the International Conference.

1104. Would you want to trawl exactly the same place three months afterwards?—As near as possible.

1105. How near would you be sure of coming to the same place in the middle of the North Sea?—That is really a question of navigation, but I think we can hit the spot with great accuracy and as near as necessary.

1106. Would you wish to get within a hundred yards or within a mile?—In most places within a mile would be quite satisfactory, but there might be certain cases where it would be necessary and easy to go much nearer—to all intents and purposes to the precise spot.

1107. Now you said something in your evidence to the Chairman about the current being affected at different times of the year?—Yes.

1108. I suppose that that would be particularly the case in the northern parts of the North Sea, the currents would be affected by the ice, would not they?—We have not yet full knowledge. The question is a question for the meteorologists—for Mr. H. N. Dickson, who has specially studied these currents, or Dr. Robert Mill. But there is no doubt that the different conditions of the Arctic ice very greatly affect the temperature and the salinity of waters in the North Sea.

1109. Then I suppose the temperature would affect the habitude of the fish and the location of the fish?—Precisely. And I know that certain of the migratory fishes, such as herring, are closely affected by certain bodies of water, their salinities, temperatures, and food contents.

1110. I want to know whether that would affect that fish—whether you think they would be affected by the currents?—I do not think so to the same extent.

1111. But to some extent the currents would affect them?—That whole question is for the future. We expect to get information that will co-ordinate the abundance, even of such fishes, with physical conditions. That is for the future.

1112. If you trawled on a certain bank on one day, and then some months afterwards somebody else came back to the same bank and found a great many fewer fish or more fish, might not that be caused by the change of current?—Yes, and it is therefore for that reason that we lay so great stress upon the hydrographical experiments to accompany all this work. That is an essential part of it. It is for that reason that the commercial statistics or the work done on an ordinary trawler will not do. It is for that reason that we want chemical analysis, physical analysis of all sorts, at the same time simultaneously with our experimental catches.

1113. What I want to know is this: whether you can be quite sure of the fact that there is a less population within, say, a radius of two or three miles, or whether it might not be the case that the fish had just shifted their ground because of the change of current?—I am inclined to think that the changes of current that I have been speaking of, these great changes of the direction of great bodies of water, are of much greater magnitude than that, that they are influences which will affect the whole condition of a coast, rather than a particular spot.

1114. You find the fish in a somewhat different place in the autumn or the spring, or the summer or winter?—We do.

1115. Also it would be the case to some extent that the season might be particularly backward or forward, and that that would affect the take, as compared with the take in the previous year?—Quite so. And then hydrographic observations, besides having a direct bearing on the fish, may also have a direct bearing upon the seasonal fluctuations of weather, the one cause may produce the two fluctuations.

1116. I suppose you will want some assistance from the trade returns for getting at the population of the sea?—Oh, clearly.

1117. But you are dependent entirely upon your special boat for the hydrographic investigations?—Entirely.

1118. Do you think that the conditions of a place like the North Sea, taking a particular spot, would vary more or less than a place like the Firth of Forth?—The investigation of the whole problem is to bear upon these inlets of the sea; an inflow of northern cold or southern warm water that creeps along the coast will affect all the inlets alike very much more than it will affect the centre of the sea. I can illustrate it so clearly by a reference to these maps of Pettersen.

1119. Do you say that the interests of all the countries who were parties to the conferences were pretty generally the same, or had different countries different interests to consider?—In certain cases it is recognised in the programme that the interests of the different countries are diverse. For instance, Sweden and Russia in connection with their Baltic fishing desire special investigation of the flounder and certain other fish to a greater extent than others. It is well laid down in the programme that certain cases point probably to a greater interest of one country than another.

1120. I may take it that Great Britain is more interested in the trawling fisheries than other countries?—Certainly.

1121. And England more than Scotland?—I cannot say the proportion to the size, and wealth of the countries, but it has become a very great industry in Scotland.

1122. There are steam trawlers at Aberdeen?—A very large number, about 150 in all.

1123. But nothing like what there are in England?—I am not acquainted with the figures for England, but I may say that there is sometimes an arrival of 250 tons of fish in Aberdeen in a morning?

1124. You do not compare Aberdeen with Grimsby?—It is next to Grimsby.

1125. Has it ever been suggested that there is any risk of the investigation conducted by the Central Bureau being more in the interests of science than in the interests of practical fishery questions?—I do not think it has been suggested; it is always difficult to draw the line. We may make a great many investigations whose immediate practical bearing is not obvious, but whose result in the end may be useful.

1126. Of course, there are some investigations that may be more immediately practical than others?—Undoubtedly.

1127. (*Mr. Green.*) So far as England, Ireland, and Scotland are concerned, is it not a fact that the only coasts which are included in this international programme are the Scottish coasts?—Is it not a fact, did you say———?

1128. That so far as the British Islands are concerned the seas off the Scottish coast are the only ones included for British investigation according to the Swedish programme?—I think, according to that preliminary delimitation, it is so, that the work in the British division is supposed to begin about latitude 54°, but, as I have already said, that is merely tentative.

1129. Supposing an area was defined which would include the whole of the British Islands, and that the investigation of that was left to England?—I beg your pardon. I think you possibly have the former year's Stockholm programme. Is that the Christiania programme you have?

1130. Yes, it is the Christiania programme?—Well, according to the newer programme the delimitation of areas is as follows (*handing the programme to Mr. Green*); but it is plain, in this very tentative programme, that the British representatives do and say little as to the areas of work until they know what means are to be at their disposal. That programme is entirely tentative.

1131. What I mean, supposing British money was to be spent on a marine investigation of the fisheries around the British Islands, do you not think that an area including the whole of the British Islands investigated by possibly three Departments, one in Scotland, and one in Ireland, and one in England meeting occasionally in consultation, would be advisable?—I think most distinctly it would. I have already said it is simply necessary, and that we should investigate the western areas and the Channel area, together with the area in the North Sea.

1132. Do you not think that some of the changes in water temperature and in plankton and all those kind of things would be met with on the west coast of Ireland, probably before they reach Shetland?—Yes; and I think they are of the very greatest importance.

1133. So that, as a whole, the British fisheries would be better investigated by an area including the whole of the British Islands than by anything in this programme of the conference?—Most certainly. I think I said before, or I meant to say before, that for our purposes it is absolutely essential that the western and the Channel area should be investigated simultaneously. But it is plain that that means a very great area, vastly greater than is contemplated here.

1134. Then if British money is to be spent, we should look out for ourselves at home?—Oh, undoubtedly.

1135. Do you think that that could be arranged by a consultative council of the three divisions of the British Islands without any actual direction?—I think it would be very convenient to have such a conference.

1136. So as to leave the initiative to each as it is?—I think it would be very desirable.

1137. (*Professor Herdman.*) I have one or two questions I should like to ask you, mainly with a view of getting your opinion in a slightly more detailed way on the points of the international scheme. You spoke of what is generally admitted, the inadequacy of the "Garland's" work. You mentioned that similar work—I do not mean carried out in the same way, but with the same object in view—was in the forefront of the international scheme. Now, are you satisfied that such work would be perfectly adequate to give us the information desired, if carried out on the lines in the printed information before us?—I am inclined to think so. I am, on the whole, satisfied with the programme.

1138. Have you formed any idea as to how many vessels would be required in this country in order to carry out that scheme adequately?—As I have already stated in reply to Mr. Green, the amount of work if all our coasts are to be involved is very great, and I am almost afraid to suggest the number of vessels that would be required for this complete information.

1139. You have not figured out a scheme detailing the particular work, and the number of boats required?—I am inclined to think that we shall require two boats to work our southern and eastern area, including the whole of the Channel and the north up to the Shetland Islands, and that it will be hard work for our Scotch boat to patrol the seas from Shetland to the north-eastern corner of England.

1140. Do you think that two boats would be anything like sufficient for that area?—I think that they would do for that area, according to the scheme.

1141. You have not planned it out to see how many days they would work on particular grounds, have you?—To a certain extent I have done so, and I am inclined to think it would be possible, but it would be a good deal. I do not think more would be required absolutely, and I think that, considering the areas Denmark and Norway expect to cover, that would be adequate. But whether it would take one or two more vessels or even more for the investigation of the western coasts, I should not like to say. I do not believe that a single Scottish ship could explore our western area without further assistance.

1142. You gave examples of the value of work on the east coast of Scotland?—Yes, when speaking of work done on the trawler.

1143. I suppose equally valuable work would be carried out with such a boat under a national scheme?—Undoubtedly.

1144. I should like if you could point out the special advantages the international scheme gives us, and why it is of great importance?—The special advantages?

1145. What international object would it serve beyond what we could get by the work in this country?—Simply that the whole physical and hydrographical question can only be dealt with efficiently by international co-operation. Experiments such as I instance in the case of Dr. Fulton's work on our Aberdeen trawler were essentially individual and local experiments. They could be done once or anywhere: to give the size of the fish passing through a one-inch or a two and a-half inch net—that could be done anywhere. But the essence of this programme is the comparative method, to show the seasonal, periodic, and other fluctuations over great areas.

1146. In the physical condition of the water?—In the physical condition of the water and the migrations and fluctuations of the fish.

1147. Would you say that it was mainly on the basis of the hydrographical scheme that you recommend the international work?—It is because I believe that the physical considerations are very largely to be brought in as explanatory of the biological conditions that I think it absolutely necessary. It has, moreover, to be remembered that only international investigation will lead to such general acceptance of facts as is likely to result in the framing of international regulations and in general to community of law and practice.

1148. Are you quite clear that the changes in the water which are outside our area of investigation, the waters that are going to be undertaken by the other countries, have a direct bearing upon the knowledge that we wish to get?—I am quite clear on that point.

1149. You instanced the movement of the herring and the possible bearing of hydrographical observations upon such movements, and you spoke of the difference between an investigation merely of the north coast of Ireland and of the wider waters of the Atlantic?—Yes.

1150. Do you think that our herring migrates into the wider waters of the Atlantic?—Really, Professor Herdman, I should be very reluctant to express an opinion on matters of that kind, if you do not mind.

1151. I mean if it does not do so, then hydrographical observations in the Atlantic have no direct bearing?—No, it does not follow at all. Hydrographic observations in the North Atlantic may be extremely important as explaining and accounting for, and forecasting the prevalence of certain conditions in particular areas of the sea and, *ipso facto*, the presence of migratory fishes there.

1152. Then I would like to ask you about the time of such investigations. Can you tell us why these four months for the periodic observations were chosen, which are spoken of as the typical months? Why were they chosen, what are they typical of?—Well, I am really not able to answer that question. They are not very much better than the months immediately before or after them—they are epochs of certain seasons.

1153. Well, are they? It seems to me that they miss the main spawning period of the fish in the spring—they take February, and then I think it goes to May. I thought possibly you might give us a reason?—No, I am not able to account for this. I may point out that the areas over which the ship is to work would take a very considerable time; the experiments would be spread over a broad period between those two dates. If we are to work from Shetland to the North of England we cannot do it all on a certain date in February. These are the starting points of the series of experiments.

1154. Are you pretty confident that if we join in this international scheme to be carried out according to this programme, that one might look for results within five years?—I think so, most assuredly. I have co-operated in the drawing up of that programme on that belief and assumption.

1155. (*Mr. Archer.*) Is the abundance of flat fishes subject to the same annual fluctuations as that of round fishes?—May I ask what you mean by the round fishes—are you speaking of the herring?

1156. I refer more to the round fish caught by the trawl, such as haddock and whiting?—I do not think that there is any strong difference between them. In regard to both fish we have occasionally local complaints of their absence. We know with regard to some of the round fishes, for instance, the haddock, that it fluctuates; it has various migrations and changes extremely well marked and well known. We go back 100 years in our knowledge of fluctuations in the

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abundance of the haddock, without the obvious agency of man.

1157. But you do not know whether flat fishes fluctuate in abundance from year to year to the same extent as haddock?——I do not think so.

1158. You were speaking about the insufficiency of the "Garland" for these experiments. I suppose your observations referred principally to the "Garland" not being able to work in the deep sea, *i.e.*, on the off-shore grounds?—They referred to that on the one hand, and on the other hand to the small scale on which all her experiments can alone be conducted, so that, in my opinion, they are insufficient for the taking of averages, and making such deductions as we desire.

1159. Have you taken any means to test the value of the work done by the "Garland" on the different stations on which she has been trawling?—I have examined the results from year to year, and it is only gradually that we have come to see that the numbers with which we deal are too small to be effective for calculation, especially when we have at the same time, side by side, and hard by, the means of obtaining experiments so incomparably greater and better.

1160. (*Professor Thomson.*) Do you think that we have available in Great Britain a body of experts as to plankton, for instance, and as to hydrography, at all comparable to what would be secured by international co-operation?—I think I may say clearly that we have not. It would be of immense benefit for certain studies, especially plankton studies, that there should be a central institution that should entrust to particular investigators the whole mass of collections, for instance, in one particular department.

1161. Is not that, then, one of the very great advantages of international versus national exploration of the North Sea?—That is a very great advantage.

1162 (*Chairman.*) Is there anything that we have omitted to ask you?—I do not think so. Should you like me to bring the German Report?

1162*. Please to send it through the Secretary?—I will do so.

Mr. William Carmichael M'Intosh, called; and Examined.

Prof. W. C. M'Intosh.

1163. (*Chairman.*) You are a Fellow of the Royal Society and Professor of Natural History at the University of St. Andrews?—Yes.

1164. Were you formerly a member of the Scottish Fishery Board?—I was for three years the scientific member.

1165. I do not think we need take you into the details of the Scottish Department, we have had that put before us by previous witnesses. Do you agree, from your experience of the Fishery Board, that the means placed at its disposal for scientific research are inadequate?—I am not quite sure about that. I think if better use had been made of the funds already in their hands greater progress would have been made.

1166. I will give an example of what I mean. It has been stated that the "Garland" steamship is too weak for the work which she is called upon to perform?—I believe that ship is wholly inadequate, but the Fishery Board is responsible for its inadequate condition since it went contrary to the advice given in 1884 and 1885.

1167. By whom?—By Lord Dalhousie, then the Chairman of the Trawling Commission.

1168. You mean it was contrary to the report?—It was contrary to the advice given by Lord Dalhousie, who recommended to the Board a very different ship, a ship capable of meeting the eastern seas, and of working an efficient trawl so as to compare its work with what had been done before, what was doing then, and what would likely be done in the future.

1169. That you say was recommended by Lord Dalhousie—was it recommended by Lord Dalhousie or by his Commission?—Both, in so far as, indeed, he asked me to draw up a series of points.

1170. Were you a member of that Commission?—I was the scientific worker of that Commission—the scientific man who did the scientific work for that Commission, and you will find it in the report.

1171. You were not a member of the Commission?—No, I was not. But Lord Dalhousie took the keenest interest in the matter.

1172-3. Could you point in the report to the recommendation about the "Garland" (*handing same to witness*)?—It was a special recommendation made by Lord Dalhousie to the Board—to the Chairman.

1174. In what capacity did Lord Dalhousie recommend?—I think he was then Secretary of State for Scotland. At any rate, as head of the Commission and thoroughly conversant with all the details that were necessary, he was in constant communication with the Scottish Fishery Board, and gave that advice.

1175. In short you think that the Scottish Fishery Board came to a wrong decision on that case?—Most assuredly, and their subsequent work was ruined thereby. All the money that was spent in these investigations was more or less spent in vain owing to the inadequacy of their ship.

1176. You hold that the conclusions founded upon the researches conducted in the "Garland" were misleading?—They were misleading, and they admit so You will see in their last Blue-book that that is so with regard to the Moray Firth. A deliberate statement is made in last year's report that the work of the ship leads to no reliable conclusions.

1177. Certain areas were closed to trawlers in consequence of these conclusions?—Yes.

1178. Is that so?—Yes. I have a note on the question. I have drawn up a series of remarks, but we will come to them shortly.

1179. I have not followed exactly the course of these notes because we do not desire at the present time to enter into the question about the effects of trawling. What we want to find out is the efficacy of the means at the disposal of the Scottish Fishery Board for forming an opinion upon such questions as trawling?—Yes, they were in a position to form a very reliable opinion if they had carried out their observations in the right way; if they had got a right ship and efficient equipment they would have been in a better position than they are to-day, as I have mentioned.

1180. You consider it of importance to have ample and correct statistics?—Most essential. These are essential, and it was Lord Dalhousie who first instituted these and arranged with the Fishery Board for their organisation. It was one of the glaring defects noticed by the Commission of 1883 to 1885.

1181. And I suppose the more extended is the area over which these statistics are collected the more instructive will be the return?—Certainly.

1182. Do you see any advantage in obtaining an independent or separate organisation for the three divisions of the United Kingdom?—I have my remarks here. Taking the first, the central body or department for the three divisions of the United Kingdom—that is what you referred to, I suppose—well, I rather incline to the view that the three divisions of the United Kingdom should have separate Boards.

1183. Can you tell us why?—Because I do not think that a central board in London would be in sufficient touch with the various divisions of the kingdom. I have no doubt it has certain advantages with regard to simplicity in administration; economy in the staff and officers; uniformity in statistics, and freedom from local influences, with a wider field for deductions. Yet it may be doubted whether the vast area and its complex and ever-varying details could be efficiently handled by one body of that nature. That was Lord Dalhousie's idea in 1885, the concentration of the fisheries work under one body.

1184. Supposing there were three bodies, one in each of the divisions of the United Kingdom, do you think that there would be any danger of their work overlapping?—That is a point that I have specially noticed; there would be a danger of their overlapping unless they were constantly in communication with each other, but, for instance, there might be certain administrative departments confined to each of the divisions of the United Kingdom. I suppose you include in your question salmon as well as marine forms?

1185. Yes, I did not exclude them?—Well, then, the Irish Board might, as they are quite in the way of doing now, take over certain experiments in regard to the salmon in an isolated salmon river, whereas the Scottish Board might take over another department perhaps specially, and the English Board another, and they would not overlap. In that way they would be in constant communication, and the work might be more readily carried out. It would be no use duplicating the work.

1186. There would be some advantage in uniformity of administration, would there not?—There would be in the saving of expense perhaps. But I question whether the vast interests committed to the care of that one body could be so efficiently attended to as in the three separate boards. Only, of course, they would require to be very efficient boards with scientific advice.

1187. Do you see any difficulty in delimitation of areas in placing, say, the northern half of the Solway Firth under the Scottish Board and the southern half under the English Board?—That leads to various anomalies; the Firth could be under one body, for instance, the Scottish Fishery Board.

1188. At present, as regards salmon, it is under two distinct boards?—I understand so.

1189. That is not an administrative advantage, is it?—No, it is not. That might be got rid of by placing all on one body, either on one side or the other. That I think is the only case where a little difficulty might occur, otherwise the three areas are very distinctive.

1190. Is there much to be done, in your opinion, in the way of artificial hatcheries of sea fish?—That is still *sub judice*. We have no proof that it has added fishes to the ocean at this moment—I mean by adding fishes to the ocean that it has increased the number of those that come to the market. We have no definite proof.

1191. Have you any knowledge of what has been done in this respect in America?—I have.

1192. Have you been over there?—No, I have not visited it personally. The only point with regard to America is the introduction of the shad to the Pacific shores.

1193. That is a very remarkable thing?—That is not on the same footing as the subject we are now dealing with where we wish to increase the forms already in the sea.

1194. Pardon me, it is on exactly the same footing. My question was on the subject of artificial hatcheries of sea fish; the planting of the shad on the western coast of North America was done by artificial hatching?—It was; I am fully aware of all that, but my opinion is not altered in the least.

1195. I understand that you think we have no statistics to show how our flat fish may be increased by artificial hatching?—No.

1196. Have you any means of arriving at an opinion on that subject?—I have not given any opinion hitherto. I am just waiting for the results of experiments, before drawing conclusions.

1197. Where are those experiments being conducted?—By the Scottish Fishery Board; you may have heard of that already. At Aberdeen, in a bay near Aberdeen; they were formerly conducted at Dunbar. When I was on the Board they were conducted at Dunbar, the artificial hatching of plaice especially—and Professor Herdman is, I believe, also following on the same lines at Piel, in Lancashire.

1198. Are the operations on a sufficiently large scale?—That is just the point; we are never sure that they are. It is very doubtful if they are, but the question is, would it be reasonable when it is adding greatly to the expense of the undertaking, and, perhaps, after all, one might not be able to draw anything very definite from them. The Americans have done it on a very large scale, but I do not know that they have increased their cod. Fishes are so variable in appearance that it would be an extremely difficult thing to prove.

1199. Variable in movement?—Yes, in connection with appearances and disappearances in particular localities.

1200. In the case of lobster has anything been done in the matter of artificial propagation?—They have done a great deal in Canada with regard to the artificial propagation of the lobster, but there also I do not know that even with this one species we can speak definitely—I really could not.

1201. Turning from sea fisheries to inland or fresh water fisheries, I suppose you would admit that there is scarcely any limit to the extent to which the propagation of fresh water fish can be carried?—No, that is so; at the same time I would qualify that remark by saying that if we could extend the spawning beds and protect the spawning of salmon, I very much doubt whether we could do better.

1202. I am not talking of salmon nor of other anadromous fish, but fresh water fish?—I beg your pardon; there is no doubt that fresh water fishes can be propagated in that way.

1203. On that analogy, assuming that there is no limit to the extent to which you may replenish fresh water with trout, perch, pike, and so on, is there any reason to doubt that if the operation could be conducted on a sufficient scale, a similar result would be obtained in salt water?—There is very great reason for doubt, because there is no parellelism between the two forms, with regard to the food, for instance, of the two types. You have in the ocean a continuous chain from diatoms to fishes, upon which the heavier fish, as well as the intermediate forms, depend, whereas in the fresh water you have a totally different condition—you have first the small area, and more or less protection, and in the case of many of the fresh water fishes the young comes into life at an advanced stage; I mean by advanced in a comparatively large form, whereas the marine fishes are produced as mere mites of things.

1204. Is it not rather a strong thing to say that there is no parallel between the two?—There is a very great difference.

1205. That is another matter?—Might I say that there is no parallelism as regards their surroundings? The ocean is such a complex field in contrast with the fresh waters that I very much question whether one can draw any conclusions from the ease with which we can propagate the fresh water fishes—I doubt whether we can draw any conclusions with regard to the ocean.

1206. Is not the chief difference one of area?—No, not area—surroundings as well.

1207. I repeat my question: is not the principal difference one of area?—You mean by area, extent of field—there is more than that.

1208. That is the chief one?—That is one.

1209. You have a great deal more to tell us than I have asked you, have you not?—Yes.

1210. (*Mr. Crawford.*) Have you considered this proposed plan of international research?—I have.

1211. Do you think that it would be attended with advantage in the way of hydrographic and biological results?—I would strike out the hydrographic entirely and commit the hydrographic scheme to His Majesty's ships or the ships of other Governments. I do not know that we can say that hydrographical work has greatly advanced our knowledge of the fisheries, and advanced our prospects indeed with regard to the fisheries. A great deal of money has been spent upon it by the Scottish Fishery Board and by other bodies I dare say in connection with the fisheries, but I doubt very much whether in that scheme hydrographic work should loom so largely.

1212. I shall not ask you to go into detail upon that. Were you a member of the Scottish Fishery Board when they made the injudicious purchase of the "Garland"?—No, I was not. It had been working for six years or more I think before I was on the Board, and it had got into a hard and fast mode of working which could not be altered.

1213. That was in 1885—16 years ago?—They got their ship in working order early in 1886 I think.

1214. The Board was constituted, I think, in 1882?—Yes, in 1882.

1215. And there are now, I understand, none of the present members of the Board who were in office at that time?—That is so.

1216. (*Professor Herdman.*) I think there was a manuscript scheme as to the carrying out of the international investigations that was submitted to the Council of the Royal Society for opinion and I think

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the Council of the Royal Society referred the matter to you?—That is so.

1217. I think it would be of great importance that you should give us the views you came to in regard to that scheme?—I shall be very happy to do so. I have already mentioned the hydrographical work. In considering this aspect of the fisheries problem it has to be borne in mind that hitherto the results of meteorological, hydrographical and other physical investigations in connection with the sea fisheries have not been of such promise as to warrant their being put in the foreground. Temperatures of surface and of bottom, the determination of currents—warm, temperate and cold—have not in any way explained the problems associated with the fisheries. Much of this may perhaps be due to the fact that some fishes are able to accommodate themselves to considerable variations in temperatures. Moreover, whatever may be the effect of the alternations of Atlantic and Arctic water in the North Sea it would be difficult thus to explain the abundance or scarcity, for example, of the herring, the perennial abundance of which does not seem to be due to such factors. Looking at the proposed scheme of the International Fisheries Conference—from the industrial point of view, the meteorological and hydrographical work would appear to offer less return for the expenditure than the purely fisheries researches—which are fundamental. It becomes a question, therefore, whether the entire energies of the Conference should not in the first instance be concentrated upon the thorough investigation of the distribution of the food-fishes and the conditions pertaining to their surroundings. It is well known that irrespective of currents, whether Arctic or Atlantic, the very young fishes invariably follow the law which regulate their appearance at particular seasons. Thus the young cod, haddock, and whiting, after their post-larval stage, are oblivious of particular currents in their movements on the one hand to shallow and on the other to deep water, and the same may be said of the young of the flat and other fishes. There is no reason to believe that the adults are affected by currents in a greater degree, except in so far as storms may bring into bays greater quantities of food, and a fish to which cold water is congenial may aproach the shores more closely in winter or may follow the organisms characteristic of such a season. The foregoing remarks are not intended to depreciate the value of meteorological and hydrographical work as a field for scientific research or in prognosticating the weather, but solely to show that such work must occupy a subordinate position in this investigation—especially in view of the limitation of funds. It would be well indeed to arrenge for the hydrographical and other physical work being carried out by the trained officers on board His Majesty's vessels and those of other nations according to an international agreement without burdening the Fisheries Conference with so heavy an expenditure. In regard to the heading of faunistic work ——

1218. May I ask whether your remarks are directed to the international programme or to the scheme which I spoke of as being before the Council of the Royal Society?—It was to the scheme before the Council of the Royal Society. The determination of the nature and abundance of the food-supply of the edible fishes is, perhaps, not of primary importance at present, since previous inquiries have rendered it plain that there is no lack of nourishment at all seasons in the ocean. The inquiries at St. Andrews and Plymouth are satisfactory on this head. It is long since, at the former place, the unbroken chain between the microscopic diatom and the food fish has been demonstrated, and the alternation of sedentary and pelagic stages in the life history of vast numbers of oceanic animals—as well as the seasonal changes in the pelagic types—shown to be indissolubly bound up with the permanence of the food fishes—notwithstanding the drain made on them by man. In regard to the mention of artificial propagation of marine fishes ——

1219. That does not form a part of the manuscript before the Royal Society, does it?—That comes under the printed programme.

1220. We are not speaking on that?—I think it also comes in that. I have notes in the manuscript here, and I think that it comes in. I will take them in the order in which they appear in the written programme.

1221. What I rather wanted your opinion upon was whether you consider that this scheme that was submitted to the Council of the Royal Society and upon which your opinion was asked (and it was thought you should give your opinion upon it here), would suffice to carry out the Christiania programme and give us the information we desire?—I have some hesitation about various parts of the programme—very considerable hesitation about several points.

1222. I am not talking now of the whole scheme, nor of the number of steamers necessary to carry out such a programme—two steamers are spoken of?—For each nation?

1223. I am merely talking of our own part of the scheme for Great Britain—two steamers are spoken of. Do you consider that that is sufficient—could two vessels adequately work the area assigned to us?—Well, they recommend two steamers, but they limit the area. Our area is chiefly on the east and west coasts of Scotland, and they excludes the English shores and the Irish shores altogether. The two steamers certainly would not work the British waters.

1224. Can you give us an opinion as to what number of vessels would be required?—To carry out these observations?

1225. Yes?—Well, in the first place the necessity for these observations on the scale that they recommend would require to be proved. We already know a good deal about the fishes of the sea, and the Norwegian exploring ship has added to our knowledge, showing that food fishes abound in vast areas away from the ordinary fishing grounds, so that to face the problems connected with fish on the various grounds on these lines would be a very serious matter, and I question whether this scheme has been sufficiently thought over to warrant our support, especially when we read of the "feeding place of fishes" and other such terms in the scheme.

1226. What is your opinion about the expenditure that is here estimated—the total is £62,000?—£12,000 for the capital sum and £10,000 a year. But of course by taking off the hydrographers you would reduce it by £500 a year. I think we cannot place very much reliance upon that estimate of the cost.

1227. Is there any other point in connection with this scheme that specially struck you?—There are a great many points. For instance, here is one with regard to the diminution of the plaice for which no statement and no statistics are given. Then I have already mentioned the feeding places of fishes; where these are I am at a loss to know. Fishes feed just where they happen to be.

1228. (*Mr. Pelham.*) They generally manage to be where they can feed?—Yes, but the ocean is so full of food that there is not much difficulty.

1229. (*Professor Herdman.*) Do you consider that four series of observations in the year is a sufficient number to give one information as to the distribution of fish on the ground?—No.

1230. (*Mr. Pelham.*) How do you consider that the fish population of any considerable area should be ascertained?—It is an extremely difficult matter to do. I have watched for more than 40 years the Bay of St. Andrews, and except that I can say at this moment that the fish fauna is very much as it was I cannot say much more. It is always in perennial abundance at particular seasons.

1231. Are you acquainted with the trawls that were taken by the "Garland" in the Firth of Forth?—Yes; I worked them out.

1232. Do you think that those returns are of any use?—They are of use so far in showing the fishes in the area at the time.

1233. Do you think that a trawl taken in one place would be any indication of what a trawl would take in a place half-a-mile off?—Not necessarily.

1234. Or 200 yards off?—No, or that might be taken by a trawl coming behind it. The trawl was so inadequate that in anything like deep water it would not work properly.

1235. Would a trawl be any test of what might take place a week after?—No.

1236. Or on the same day in the following year?—No, or as I said by a trawl following.

1237. That is stronger still. I suppose there would

he the same variation as regards the size of the fish, would there not?—Yes, except with regard to flat fishes. I know that in-shore the flat fishes, such as the plaice, are small. The large plaice live off shore.

1238. Do you think that the bottom of the sea would vary more or less than in the inland waters?—Than the open ocean?

1239. Yes?—In regard to drawing conclusions?

1240. Yes. I meant would you expect to find that the same place would vary from day to day more in the open sea than in the estuary?—I have very much doubt. I do not think I would make any very strong statement about that. Both would vary.

1241. And the position of the fish would vary according to the temperature of the water?—I am not quite sure about the temperature, but the food upon which the round fishes feed (like herring or sand-eels) would perhaps leave the particular spot, and the fishes would follow and there would be a great change the next day.

1242. And the food would go with the current, I suppose?—Certain pelagic flat fish might, but herrings and sand eels would not.

1243. I suppose the flat fish are much more stationary naturally than the round fish?—Yes.

1244. Do I understand that you consider that the experiments proposed by the Conference would be of very little use?—Well, I mentioned that I am doubtful.

1245. But you said that you would separate the ordinary experiments from the hydrographical experiments?—Yes.

1246. Is it not necessary to ascertain the quality and nature of the water at a particular place where particular fish are caught?—Yes, that is interesting, but it is expensive, without adding very much to our information with regard to the food fishes.

1247. You suggested that the hydrographic experiments should be made by cruisers?—Yes.

1248. Then you would not know what fish would happen to be in the water at the time?—It is true, but that shows precisely the value I put on hydrographical work in connection with the practical investigation of the fisheries.

1249. I do not quite understand?—That indicates the value I put upon the hydrographical work in connection with the practical investigations of the fisheries.

1250. Would you test the population of the sea more by trade returns than by the experiments of a particular boat?—An efficient boat working on certain lines, at particular periods of the year, would certainly give us very accurate data, but I also think that the commercial boats should hand in daily, or at least when they return to the shore, statistics of their captures, and note the ground, the weather, and the depth of the water. That I think you will find printed in the report of 1884, and I have never varied in giving that advice since.

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1251. You would be able to give a certain result rather quicker if you had 100 boats, making a return every week, than by getting the return from one boat making an experiment every three months?—Certainly. I do not see what advantage an experiment of three months would be, carried out in such places as those referred to.

1252. What importance would you attach to a trawler going from time to time over exactly the same spot?—No one can take a trawl exactly over the same spot twice—the currents are against it and also the other conditions of the ocean. I tried it well in 1884, and was never satisfied that I accomplished it once, although I had opposite shores to guide me.

1253. And it would be more difficult in mid-ocean?—Much more.

1254. (*Mr. Archer.*) In your trawling experiments in 1884 did you sometimes have occasion to go over the same ground several times?—I purposely did so in St. Andrews Bay.

1255. And with what result?—Very similar to what might have been accomplished elsewhere—there was no differentiation—there was no distinctive result.

1256. Did you get the same quantity and description of fish in each haul?—Very much the same.

1257. Can you give us the reference to where those figures are published?—I think you will find a special chapter or paragraph rather upon the subject in the report of 1884, "The result of successive hauls over the the same grounds," but I qualify "the same grounds" by the remark I have just made that it is impossible to draw a trawl over a straight line, as it were, twice.

1258. In your book "The Resources of the Sea," you refer to four trawling experiments made in the Moray Firth—in January they were made, I think?—In April, I think.

1259. Were these all made over the same ground?—No, I think, they were made at different stations; they were over the same area, but no attempt was made to go over the same ground. The ship steamed round and made the hauls in the usual way, but we had no thought then of keeping to the same ground.

1260. You had no thought of keeping actually to the same place, but you were fishing on the same bank?—On the same fishing bank—Smith Bank.

1261. (*Mr. Crawford.*) If you could send in that manuscript of which you read portions we should be very glad?—I shall be very happy to do so. I spent some time upon it, and it records the result of nearly 50 years' experience of the fisheries.

1262. It will be of great use to us if you will let us have it?—I shall be very happy to do so.

FIFTH DAY.

Wednesday, 4th December, 1901.

PRESENT:

DONALD CRAWFORD, Esq. (in the Chair).

WALTER E. ARCHER, Esq.
The Rev. WILLIAM SPOTSWOOD GREEN.
Professor WILLIAM ABBOTT HERDMAN, F.R.S.
The Hon. THOMAS H. W. PELHAM.
STEPHEN E. SPRING-RICE, Esq., C.B.
Professor J. ARTHUR THOMSON.

R. E. MARTYR, Esq., *Secretary*.

Dr. D. NOEL PATON, called; and Examined.

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1263. (*Mr. Crawford.*) You are the Superintendent of the Laboratory of the Royal College of Physicians of Edinburgh?—I am.

1264. And you are a member of the Royal Commission on Salmon Fisheries?—I am.

1265. And you are editor and contributor to the work on the "Life History of Salmon," published by the Fishery Board for Scotland?—That is so.

1266. You have given us some headings of the evidence which you propose to give us. How do you intend to treat the subject?—I thought, in the first place, of considering the question of what the objects of

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scientific investigation should be; then passing on to consider who might best direct such investigations, and finally considering the methods which would probably yield the best results in such investigations.

1267. What do you think ought to be the objects of ichthyological investigation?—Before proceeding to state that, might I say that I do not present myself as a fishery authority, but as a scientific man who has dealt with scientific work as Superintendent of an important laboratory, and who has had to direct scientific work and to consider the best methods for carrying on scientific work. My knowledge of fisheries has been derived partly from laboratory work done, work which I have done and work which I am still doing, and partly from being a member of the Royal Commission on Salmon Fisheries, on which I have had to consider the relationship of evidence to fishery questions.

1268. You have given a good deal of time to the subject in that way, have you not?—Yes, in that way fishery questions have been largely forced on my attention. Then, to begin with, I take it, of course, that the proposed scientific investigations should have a practical object and that the investigations are intended to take the direction of an organised attempt to determine certain points. Firstly, whether the number of fish in our inland and marine waters is increasing or diminishing; secondly, if there is any decrease, to find out the causes of that decrease; and thirdly, to find out how any decrease may be checked or prevented. In fact, I take it, it is very much the application of science to fishery questions as you apply it to medical questions, namely to find out whether anything is wrong, and what is wrong, and, secondly, why it is wrong, and not until you have done this to attempt to treat the condition.

1269. To apply the remedy?—To apply the remedy. Well, the first note I have is that the question of these scientific fishery investigations appears to me to be a national question, and it seems to me to be so, firstly, because the value of fish landed in the United Kingdom annually is so very great. I find from the statistical tables of 1901, page 6, that the value of fish landed is something like 10 millions per annum. Then, secondly, the question is a national one, I think, because the fish is a most valuable and cheap food for the people. In the "Dietary Studies of the Labouring Classes of Edinburgh," which I along with Dr. Dunlop have published, he analyses the foods used, and he says that 'fresh fish is a good, cheap, proteid-rich food, and might, with advantage, be used more freely in the diets of the labouring classes to augment their proteid value," and he calculates that "the proteid is only a little more expensive than that of bread and much less expensive than that of beef, milk, or eggs." Therefore the fish landed is a matter of importance to the food of the people. And, thirdly, I think it should be a national question, since so large an investigation should be carefully co-ordinated and controlled to avoid useless expenditure of money and energy, and to prevent overlapping, such as would occur were it left to local effort. I think the necessity of such a central control was recognised at the Christiania Conference, where an international board controlling such investigations was suggested. And, lastly, I think it is a national question because regulations founded upon these investigations may possibly lead to international complications, as in the case of the Moray Firth in Scotland. On the other hand, I should certainly think that local efforts should be utilised and encouraged, but should be brought under central control, firstly, in order to make the results of those different local workers comparable with one another to, as it were, standardise the work and, secondly, because I think that imperfectly planned work, or work inefficiently carried out, may lead to conclusions the application of which may possibly do more harm than good. I do not know whether I am right in referring to this matter, but it is quite a public matter that the author of the "Resources of the Sea" has criticised very unfavourably certain work carried out in connection with the "Garland's" experiments under the Fishery Board for Scotland, and has at least shown that those researches were capable of being more carefully planned and more carefully carried out than they really were.

1270. We had Professor M'Intosh's evidence yesterday?—Of course I do not know what his evidence was. Then when one looks at some of the statements brought forward in connection with the fisheries in the North Sea one finds, I think, instead of there being really scientific observations, and tables being given in support of them, they are very often mere expressions of opinion. For instance, here I have a report "Of the Grimsby Trawl Fisheries and Distribution of Immature Fish," by Mr. Ernest W. L. Holt. There is one paragraph to which I wish to call attention:—"No one conversant with the Grimsby market will be disposed to say that the subjoined table of proportions is far from the mark: proportion of plaice landed at Grimsby, eight inches and above 99·9 per cent.; less than eight inches 0·1 per cent." Now, so far as I can find in this report you have no tables to substantiate that statement. On page 74 of the report you have a table giving the numbers and proportion of plaice landed below 13 inches, but no measurements below those of eight inches. Then, again, I find, and I had better quote his own words: "In 13 hauls made in the neighbourhood of Borkum and Schiermonnikoog 141 baskets of plaice were caught. Of these 93½ contained saleable fish from about 7 to 13 inches, which were brought to market. The remaining 47½ baskets, consisting of about 4 to 7 inches were shovelled overboard." Now this evidence was used before, I think, the Select Commission upon Sea Fisheries in 1893 in order to substantiate the claim of the Grimsby Association. You will find it on page 1, question 13, of the evidence of the Grimsby Trawlers' Association for the protection of certain areas in the east side of the North Sea, which are defined in the evidence of this association given by Mr. Towse. Upon looking at the chart you will find that the area to which the conclusions arrived at by Mr. Holt are to be applied is about 30 or 40 miles from the district in which those 13 trawls were made. Now I do not wish to disparage the results, but it seems to me that this shows the necessity for a careful central control of any work of this kind.

1271. I presume Mr. Holt, who has also been a witness before the Committee, was making these investigations for the Marine Biological Association of Plymouth?—I understand he was.

1272. Under any system that could be devised might there not be a fault of that kind, that is to say, a single investigator would make his report, and whether it was made to a central authority or to any other authority, of course, he would be liable to be mistaken would he not?—I should perhaps, however, state that these reports should be made to the central authority, who would deal with them and probably would find out the fallacies in them and correct those fallacies, and they would in planning the work make suggestions to prevent the possibility of them.

1273. (*Mr. Spring-Rice.*) I think in that case your criticism was not on Mr. Holt's observations as to the number of baskets and so forth, but as to the use the Grimsby Trade Association made of those observations?—My criticism was rather in the application of takes of fish at one locality being applied to conclusions as to the administration in another locality 40 miles distant, and it seemed to me to be unscientific.

1274. That was the action of the Grimsby Association, and not of Mr. Holt?—That I understand.

1275. (*Mr. Crawford.*) Is that so? I am not quite sure that I understand it aright. I thought that you did rather criticise the report of Mr. Holt on its own account?—Yes.

1276. You think that his statement, as put, leaves room for a fallacy?—Yes, I think that had this investigation been more carefully planned to begin with, such a mistake would not have occurred—such a possible fallacy.

1277. You know the value of Mr. Holt's work, but you take exception to his argument from the facts in this particular case?—Yes. I simply want to say, speaking impartially, it seems to me to be unscientific to apply results at one point to a district which is 40 miles from that point.

1278. You give that as an illustrative example of the desirability of the Central Board?—Yes, or of local effort being under the control of a central board. My argument was that the investigation should be taken up as a national question; and I now go on to say that the investigation should be controlled by a central fishery authority for all parts of the United Kingdom, which might be composed of members of the Fishery Department of the Board of Trade, of the Scottish

Fishery Board, and of the Board of Agriculture for Ireland.

1279. With regard to the constitution, I will just mention this in passing, have you considered if the board was so composed the difficulty of its holding sufficiently frequent meetings? Would it not be very difficult for the members of the Fishery Boards of Scotland and Ireland to attend here—this would naturally be the place to attend—sufficiently often to make it a useful and effective authority?—To my mind the matters seem to be of sufficient importance to require the appointment of men who would be able to give their time to the subject. As regards the members, in my opinion they should have a knowledge of the methods of fishing and the methods of fishery researches and of the administration of the fishery laws. I do not think it would be advantageous that they should be professed biologists or professed physicists or professed physiologists or professed chemists. I think that the province of these is rather to carry out definite lines of work than to deal with the larger and more practical aspects of the question. Now, in illustration of this I think I might cite the work carried on under my direction in the Laboratory of the Royal College of Physicians of Edinburgh upon the life history of the salmon. Our salmon investigation illustrates the relationship of the scientific worker with the Central Fishery Authority. The then Inspector of Fisheries for Scotland, from his large experience of fisheries, was able to state what he thought should be the line of investigations and to discuss the methods of carrying them out, and to plan the taking of suitable samples and to test how far those samples were typical. It was upon these—upon the samples so procured, our biologists, physiologists, and chemists were then able to work with some certainty. It seems to me that the members of this controlling board should be largely relieved of the drudgery of ordinary administrative work, and should have leisure afforded to suggest, direct, and guide investigations. I do not know that I have any right to speak of the evidence laid before the Salmon Fisheries Commission before it is published, but Mr. Fryer, from the Board of Trade, gave us such an amount of the details which the Fishery Authorities, or those dealing with fishery questions on the Board of Trade had to deal with, that it was quite surprising that they were able to consider the scientific side of the question at all.

1280. Do you mean the details other than scientific?—I mean the details other than scientific. We found that they had to consider all sorts of questions about registration of trawlers, and the names of trawlers and matters which appeared to be outside the province of Fishery Authorities. I think that this board should have under them a staff for carrying out scientific investigations. Some of this staff would be permanently employed for the collection of statistics, making of measurements, and so on. Others, again, might be engaged as required by securing the services of biological workers and their laboratories when any question had to be worked out, as was done, for instance, in the case of the salmon work for the Fishery Board for Scotland carried out in the laboratory of the Royal College of Physicians of Edinburgh. In my opinion, the plans of investigation would necessarily be left in the hands of the fishery authority. And it seems to me that the methods which would have to be employed might be divided into two heads, first, the methods of using commercial statistics and commercially procured material, and, secondly, special methods of investigation. It seems to me that these two methods might be applied equally to inland and to sea fisheries. In speaking of inland fisheries I would include salmon fisheries. If you will allow me I should like to speak of inland fisheries, since it is with these I have been specially connected, and because I think that the manner in which our knowledge has been gained and is being gained upon these questions, and the manner in which it is being applied to fishery regulations, might with advantage be applied to the study of the sea fisheries. Taking, then, the first question that requires investigation, that is, the question of deterioration or improvement of salmon fisheries and the number of fish, I may say that the want of statistics in many districts investigated has proved a great difficulty to the Royal Commission on Salmon Fisheries in coming to any conclusion as to the state of the fisheries. It is not generally incumbent upon fishermen to make returns of the fish captured, and it appears to be directly to their disadvantage to do so.

1281. You are speaking of inland fisheries, including salmon fisheries?—Yes. Many of the Scottish tacksmen have supplied the Salmon Commission with confidential returns of their takes for some years, and although these are probably sufficiently extensive to give a fair idea of the state of some of the sea fisheries, they are still very incomplete, and give no reliable information of the fisheries as a whole. When Inspector of Salmon Fisheries for Scotland, Mr. Archer, succeeded in introducing a system of obtaining information from railway and steamboat companies of the weights of salmon carried from different stations, and these returns have proved of considerable value. The value of these returns was pointed out by Mr. Calderwood in his evidence on page 425 of the Salmon Commission. I think it should be made compulsory that the statistics of the takes of fish should be given to the fishery authorities, though not necessarily for publication. The probable attempts at falsification of these statistics might be checked by railway and steamboat returns of the number of fish carried. Now, of course, it may be argued that the total take of salmon is no measure of the number present, and that it depends rather upon special conditions of water, favourable or otherwise, for fishing or for special lines of migration, or upon alterations in the means of capture than upon the number of fish present. With the condition of the waters, the lines of migration of fish, I think it is impossible to deal, but they will tend to equalise themselves over a period of years. It must be remembered that the period may be a long one. For instance, the very dry character of the last three years has been associated with a very marked decrease in the number of salmon captured. I do not know the cause or relationship of that, but I merely note it. But the influence of the power of capture, I think, is capable of a more or less perfect expression; and I think I may best illustrate this by reference to the hag nets along the coast of Scotland. As you know, these extend over very considerable distances along the coast, and are very frequently placed at short distances from one another, and we have evidence that in those ranges of nets each net of a series captures a certain proportion of fish. And therefore we may assume that the fish, in passing along the shore to a river, do not travel parallel to the shore, in which case they would be all captured, but I think our evidence goes to show that the fish come in more or less diagonally, possibly moving in and out with the tide. Making that assumption, and assuming that the density of the fish, that is the number per unit of area, remains constant along this range of coast, we are then in the position to study the influences of altering the number of nets. I may illustrate it by this diagram. We may say you fish inside this line, along the outer end of the nets, and by representing diagramatically the density of the fish, by representing your nets at various intervals you can then study the capturing power of the whole number of nets, and the capturing power of each individual net, as you increase the number.

1282. By varying the number of nets?—Yes, by varying the number of nets. Now if we do so we shall find that at first as we increase the number of nets they do not interfere with one another, and the total of take increases proportionably to the number of nets, while the take per net increases in the same proportion.

1283. Then how do you ascertain that—by such statistics as you have been able to get?—No, by considering the fish passing in and considering the position of those ranges of nets. Take, for instance, these nets at a considerable distance. Let us say the density is represented by these two lines (*describing*), this will take two fish; a net over *here* will take two fish, but I have a net somewhere in between, and according to the density of fish it will either take the same number or a less number. If one takes a less number then the rest obviously the total take will no longer increase in the same proportion, and the take per net will begin to fall. I might represent that diagramatically (*Diagram handed in by Witness.*)

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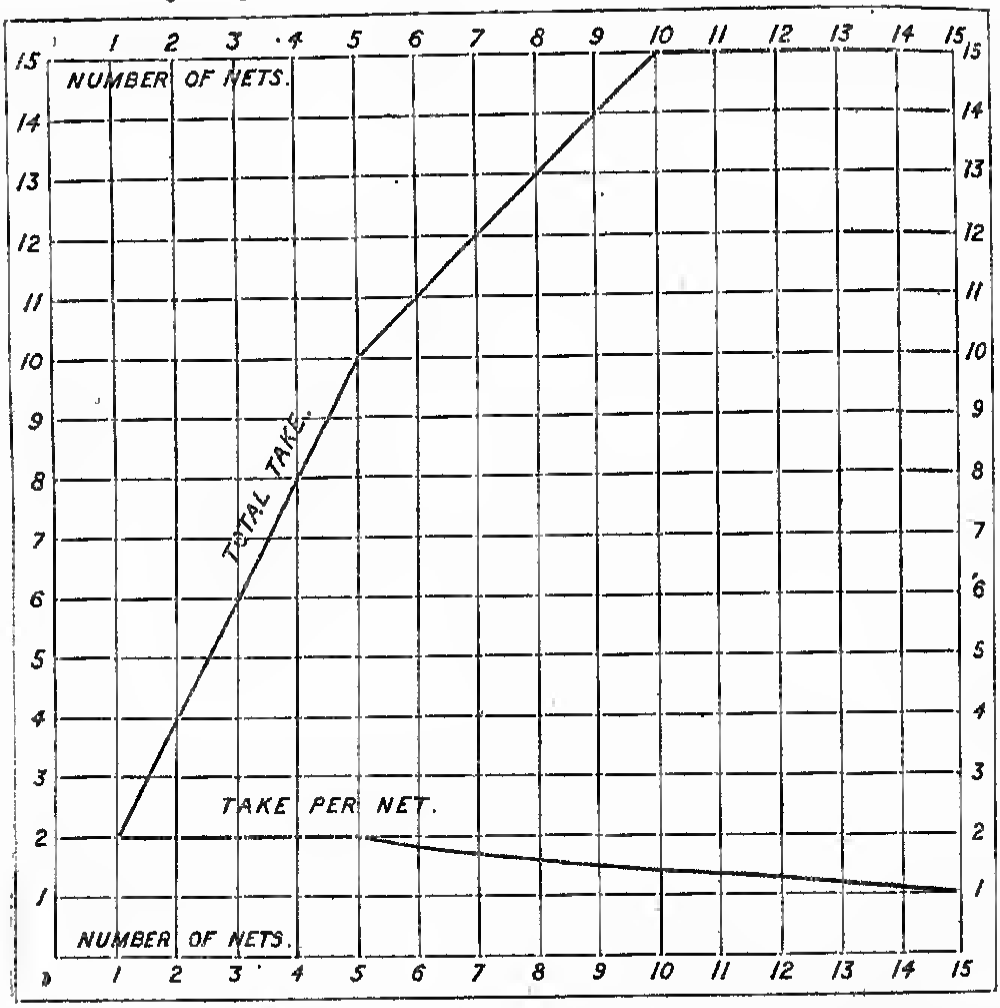
Diagram representing Total Take and Take per Net in a Range of Bag Nets



1284. Is that purely theoretical, however clear it may be—assuming the density of the fish to be constant and taking the number of nets, as you propose—is it purely theoretical or is it the result of experiment or of your experience?—It is based upon two assumptions. Firstly, that the fish approach the mouth of the river in the manner I have considered, and, secondly, that the density of the fish is the same along the range of nets you are considering. As a matter of fact, the density is not the same, but to get the result of varying density you have simply to shorten the distance, when you will get the result of varying densities in different districts. Might I just represent very roughly the effect of increasing the number of nets? At first as you increase the number of nets, supposing you have two nets you increase to four, and you will have an increase of two—two fish taken in each net, and the total take will be four. The total result will rise rapidly in proportion to the number of nets, and then you will reach the total take less rapidly, and then finally the total take will no longer increase but will remain equal, as the number of nets increases.

1285. You have got all the nets that the ground will hold?—Yes; at the same time the take per net will at first remain constant, but after a certain period the take per net will begin to fall, and will go on falling in proportion to the number of nets introduced. I think I shall be able to explain the importance of that conclusion presently. If the assumed density of the fish falls, that is, if the fish per unit of area decreases, then your two curves will maintain the same relationship to one another. But, of course, they will be lower. The periods will occur somewhat sooner in both the cases, but they will remain proportionate to one another. From this I conclude that a certain decrease in the average take per bag net is not necessarily indicative of a decrease in the number of fish.

1286. Does that amount to any more than this—but perhaps it does—that supposing you start with six nets on a mile of coast and you suddenly multiply that number to 12, and then you find that the take per net is materially decreased it would appear to me at first sight to be a very obvious conclusion that you could not say that the total number of fish had decreased—does it come to more than that?—It is of importance, I think, because this take per single net has led the Norwegian Commission on Salmon Fisheries into what seems to me an exceedingly curious mistake. I will read the translation of the appendix made for the Irish Commission on Salmon Fisheries at page 11: "On account of the defective statistics during the first 10 years of the period 1876-94 it cannot be satisfactorily ascertained what the result per bag net exactly represented; but it is beyond doubt that during the first years of the period it was distinctly higher than in the last." That is not based upon scientific evidence, but that we need not pay attention to. It goes on: "For the 10 years 1885-94 we append below a table which expresses in kilogrammes, as compiled from statements actually to hand, all the quantity of salmon taken with a bag net." Then come the number of salmon taken in the bag net for 1885 to 1889 and from 1890 to 1894. From this fall, the fall of one bag net, it goes on to say: "Thus the result in these 10 years has gone down by 27 kilogrammes for one bag net or by 150,714 kilogrammes for the entire number of bag nets." Whereas there are figures in the Report to show that the Norwegian take is maintained or increased.

1287. It is only that the take of that particular net has diminished, the fact being that the number of nets has been largely increased?—I want to point out the fallacy of a single net as an indication of the increase or decrease of the fishery. What I want to emphasise is that in order to establish a decrease you must consider

two factors—the total take and the take per net. I shall afterwards have to refer you to a letter to me from Professor Chrystal upon the subject of the manner in which the decrease will occur. That I keep for my consideration of sea fisheries. It therefore seems to me essential that to form any opinion of the number of fish present in considering the salmon fisheries just now you must have statistics of the total take, and as far as possible statistics of the take per net or per range of nets. To my mind I have spoken of the hag nets upon the coast, but the same law will apply to river nets. If the number of nets did not interfere with one another then you get an increased take proportionate to the number of nets, and the take per net will remain the same, as in the case of the Fraser River. Having considered then the manner in which we ought to attempt to establish whether there is deterioration or increase in the salmon fisheries, I then go on to consider how to investigate the causes of any variation, and for this purpose I think it is obvious that a full knowledge of the habits and history of the fish you are studying is necessary, and in the case of the salmon this has been gained to a great extent by using the produce of commercial fisheries for an extensive series of weighing and measurement, determination of sex, etc., etc., on as large a number of fish as it has been possible to obtain. In this connection I may refer to the work of Miescher at Basle by using the fish captured in Herr Glaser's fisheries from Istein to Lenzenberg, 500 miles up the Rhine, on which he was able to arrive at important conclusions as to the variation in the number of salmon in this part of the river at different seasons, and as to the condition of the fish at different periods of the year. I refer you to the "Statistische und Biologische Beitrage zur Kentniss vom Lehen des Rheinlachses im Susswasser." (Arbeiten 1897, p. 116).

1288. Does he get this total from commercial statistics?—From Herr Glaser's fisheries on the Rhine, working with the material from those fisheries. Then Hoek in Holland has also been able, by using the salmon sent to the market at Kralingsche Veer, near Rotterdam, to investigate many points in connection with the migration and life history of the salmon leaving the sea. That is to be found in the Statistische und Biologische Untersuchungen an in den Niedarlanden Gefangenen Lachsen, 1895. I have those with me if you want to see them. Then Mr. Archer, with the assistance of Grey and Tosh and the co-operation of the Berwick Salmon Fishery Company, has carried out an extensive series of investigations on the salmon entering the Tweed. The result of these investigations is published in the 14th annual report of the Scottish Fishery Board, the section upon salmon fisheries. Then, further, Mr. Archer, by obtaining the weighings and measurements of salmon from different parts of the Scottish coast has shown that in various stations their condition closely corresponds. This he deals with in our "Report on the Life History of the Salmon in Fresh-water," page 9. Then, after such investigations of the general characters of the life history of salmon in different positions and at different seasons, it became possible to carry out further investigations on smaller samples, because we could now test those samples and say whether they were typical, and such investigations were carried on at the Royal College of Physicians under my directions. You see that from Mr. Archer's previous statistical work it was possible to test how far samples used by us in working out the changes which salmon undergo in fresh water were really typical. The fact that the female fish from estuaries examined by us corresponded so closely with a large number of fish from different stations examined by Mr. Archer justified us in forming definite conclusions from our results.

1289. I am not quite sure whether I understand that. Do you mean in respect of the size that they were typical?—They were typical as regards their proportion of length, weight, genital development, and so on.

1290. All those points had been given in the statistics obtained by Mr. Archer in the way you describe?—Yes.

1291. So that you have the averages before you?—Yes.

1292. And then you take specimens which you find corresponded?—Yes, and in the case of the female fish we find that they correspond closely, and therefore justified us in drawing definite conclusions. On the other hand, the small number of male fish examined did not so closely correspond to the standards established by Mr. Archer from the comparatively small number of male fish which he examined, and therefore we were very guarded in drawing conclusions from the results of the male fish.

1293. How did he examine more female fish than males?—Because apparently there are more female fish than males—at least, we have not been able to procure the same number of males. Now, so far I have been referring to commercial material. But as regards salmon fisheries special methods of researches are certainly required; and since the salmon lives part of its life in the sea and part in the river we require more information as to the physical conditions of the sea, which I shall speak of later, but, as a Commission, we have felt the want of proper statistics of rainfall in various river basins, heights of rivers in different years and at different seasons, and the condition of the water of the different rivers, and to obtain this information would require a carefully planned scheme of work in carrying out which local conservancy boards and their officers might be utilised. Just now, for instance, as a Commission, we have had to deal with some questions of pollution, and we have induced Mr. Naylor, of the Ribble Board, to undertake investigations upon pollutions at the mouth of the Ribble. That is an example how central authorities might utilise local authorities. And then, further, as regards the biological history of the salmon, on which more work is required, before fully considering such remedial measures as artificial propagation, we must have fuller knowledge of the productiveness of natural hatching and of the food supply of young salmon in the rivers. The amount of information we have gained as the results of the work already done is so far small as compared with the amount of knowledge we require before we know the factors influencing the yield of our salmon fisheries, and before we can properly and adequately indicate the remedies which should be applied. But I think the statistics which have been collected form a valuable basis for further work. I have gone into this question of salmon fisheries because it is the fishery with which I am most familiar, and because it indicates the methods for sea fisheries. If you will allow me, I shall consider the methods of scientific research as they relate to sea fisheries. The first point is to study whether there is a deterioration or an improvement, and I think here again the first desideratum is to obtain commercial statistics of the total take of fish to determine whether any alteration in the productiveness of the fisheries and in the number of fish is taking place. As regards trawl caught fish, I think this can best be done for such an area as the North Sea by using British returns, because I find that there are 1,100 British trawlers at work against 200 belonging to other nations. This I find in the 16th Annual Report of Inspectors of Sea Fisheries in England and Wales, page 16, and I think the collection of statistics on this point is rendered more easy because something like 92 per cent. of all the fish trawled are landed at 18 ports in England. My authority for that is the Statistical Memorandum, page 28, Table 4. The information in this matter might be got in three ways, first by getting statistics of the number of trawlers and their trawling capacity, and I understand this is done to a considerable extent just now; secondly, by making it a condition of the licensing of a trawler that returns of the takes of fish and of the localities of the various takes should be made to the fishery authorities. I understand that in Scotland, under the Act of 1885, the Fishery Board has powers to require certain returns of this kind from captains of trawlers. And then, thirdly, by the appointment of a staff of collectors of statistics at the various ports appointed by the fishery authority, whose business would be, first, to keep records of the fish landed; and, secondly, to ascertain where they had been caught; and, thirdly, to secure fair samples of the various takes for further investigation as to size, sexual maturity, food in stomach, and so on. I think that is pretty well in accordance with the recommendations of the Christiania Conference, page 15.

1294. To some extent that system is in existence in Scotland, where we have both fishery officers in each district and correspondents who get a small allowance?—I understand that it is also in operation in certain of the chief ports of England, but, so far as I can learn, it is a system that wants further development. To my mind, with very little teaching men of average intelligence could be trained to take the necessary weighings and measurements. In my work upon the salmon I have found that a well-trained laboratory servant performs such mechanical work in a thorough and conscientious manner; in fact, I was going to say almost better than a more educated man, to whom such

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routine work is apt to prove irksome, and certainly he does so without the bias which the most conscientious scientific man cannot help allowing to influence his mind; and in all such work I have a great belief in the man without any bias. It seems to me that statistical returns collected in that way are of prime importance to give the estimation of variation in the number of fish present. The same difficulty meets us here as with the salmon—how far do the fish taken represent the number present in the sea; how far is the number of fish taken determined by other factors? For instance, by the number of boats fishing, by the kind of engines used, by the duration of each fishing, by the distance fished, and by an as yet unknown factor, the recuperative power of any particular area. This recuperative power must depend largely upon the physical conditions as to the currents, the temperature, the food supply, and so on, and the presence or absence of spawning fish in other areas. But it seems to me that, just as in considering a rangs of salmon nets so in considering a trawling fleet, if the total catch keeps up while the take per boat does not fall below a certain proportion to the number of boats, you cannot conclude that there is any decrease in the number of fish present—that a mere decrease in the take per boat or in the take per trawling unit is not in itself an indication of an actual diminution in the density of fish.

1295. That is to say, supposing the area is the same, and that the total catch is the same; but you have, say, thirty boats fishing the area where only twenty or twenty-five have fished before, and if each of those boats catch less, you have no right to conclude that the population of the sea is less?—I think not.

1296. (*Mr. Pelham.*) You would go beyond that—you go further than that?—I do not think I would go further than that. I think there is no evidence from that that the density of fish has diminished. I do not want to go further.

1297. That is to say, if the unit was less it would not necessarily be a guide?—If the take per unit was less.

1298. (*Mr. Crawford.*) That is, I presume, the take per each boat?—The importance of this is that Mr. Garstang in his article "On the Impoverishment of the Sea" takes the average take per trawling unit as the most reliable index to the density of the fish?—Well, I had the curiosity in coming up yesterday to look at some of Mr. Garstang's tables in that article, and to compare them with the conclusions I had arrived at as to the influence of increasing the number of boats upon the total take, and upon the take per boat.

1299. When you spoke of boats just now, you took boats for the sake of hypothesis?—I ought to speak of trawling units. I took his table on page 27 of the yield of the Grimsby fleet, and I worked out the proportionate increase in the number of boats, the proportionate rise in the total take, and the proportionate fall per trawling unit, and I found that they corresponded to what I should have anticipated, had the density of fish remained the same throughout the period; that is, that the fall per boat as ascertained by him did not exceed what we would have expected if the density of fish had remained the same. And therefore it was unjustifiable to conclude from that that there was a fall in the density of the fish. I will supplement this by the following table, showing that the fall per trawling unit recorded by Mr. Garstang in the Grimsby fleet on p. 27 of "On the Impoverishment of the Sea" does not prove a diminished density of fish:—

Proportionate—

Increase of Fishing Units.	Increase of Total Take.	Decrease of Take per Unit.
88 to 180	70 to 103	80 to 58

Which is proportionate to the following changes in a series of hag nets previously described (Q. 1284), when the density of fish is unaltered:—

Increase of Nets.	Increase of Total Take.	Decrease Take per net.
5 to 10	10 to 15	20 to 15

I may say that I also applied this to page 34 with much the same results. I do not wish to criticise the work of this gentleman, but simply to take what came to my hand as an illustration of the necessity of really understanding the meaning and the effect of increasing the number of vessels upon the total take. I think it has not been sufficiently recognised. I have worked that out in what may be considered a very extreme case of a number of trawlers working over a limited area, and the figures, which I shall be glad to put in, but which I need not weary you with, bear out what I have said. Accepting, then, my conclusion that absence of increase in the total take of fish with a certain fall in the take per trawling unit is not indicative of the diminution of density of fish, I will now pass on.

1300. Not necessarily?—Not necessarily. I have now to consider the case when the method of fishing begins to diminish the density of fish. When this occurs, the total take and the take per boat will fall in the manner clearly indicated by Professor Chrystal in a letter which he was good enough to write to me on this subject.* I have consulted him on various of those problems, and if you will allow me I will put in this letter. It is much too mathematical for me to deal with it. I can put the results before you quite briefly. Well, he has, of course, to make a certain assumption to begin with, that is—we assume that the take is proportionate to the surface density. He then works out the effect of a fleet of a definite size—an unvarying size—working continually upon that area, and he excludes the recuperative effect of the area, because, of course, it is impossible to reduce that to mathematics. Working in this way he comes to the conclusion that with the fleet of constant size the take will vary in a manner roughly indicated by such a curve as this—I mean to say that the density of fish will vary in a manner indicated by that curve, and that the take of the fleet, and therefore the take per unit, will vary in the same proportion—that the two will run parallel to one another.

1301. Excuse me for a moment, is this your own pencil diagram?—This is his.

1302. I want to know what you mean by a recuperative power of the area. Does this, for the sake of theory, assume that one year with another no fish are produced by natural generation?—Yes; he considers the fish practically as inert matter.

1303. (*Professor Herdman.*) Simply exhausting a stock?—Yes.

1304. (*Mr. Crawford.*) Just to make that a little more clear. Did this experiment extend over more than one year, because if it did not it would be in accordance with fact that fish would be reduced without recuperation; on the other hand, if you go two or three years, of course it would not?—According to Professor Chrystal, you can only approach the question mathematically by discarding factors about which you do not know at all, such as recuperative power of a given area, and for that reason he does not specify over what range of time such experiments would have to be carried out.

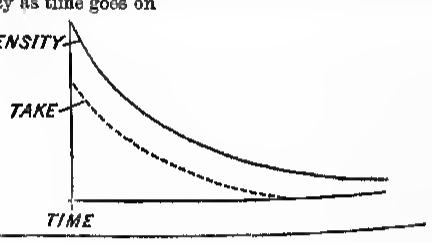
1305. It is immaterial?—Yes.

1306. The recuperative element is excluded altogether?—Yes. Then he goes on to calculate the effect of varying the efficiency of the trawling fleet, and he shows that as such efficiency varies, at first the take is in proportion to the density rises; it is obvious after a time this ceases, and the take and the density fall in very much the same curve as is indicated there (*showing diagram.*)

1307. Will you hand in that diagram?—Yes. I have tried to represent his two curves upon the tracing, the lower line represents the take and the upper line the density.

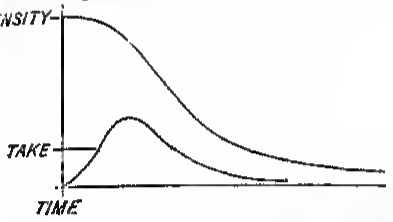
(*Diagram handed in by Witness.*)

Curves to represent relationship of "*Take*" to "*Density of Fish*" with a constantly working fleet of unvarying efficiency as time goes on



* *See* Appendix III.

Curves to show influence on "*Take*" and "*Density of Fish*" as time goes on of increasing the efficiency of the fleet from Zero upwards.



1308. And they are intended to be quite parallel—they are not exactly at the end. These two curves are parallel I presume, or are they not?—*This* represents the increase of efficiency; *this* represents the density where the efficiency is very small. As the efficiency increases, the density slightly diminishes; but when the efficiency reaches a certain point the density and efficiency practically decrease in the same proportion. The importance of that is that it again brings out the impossibility of considering the relationship to the taking unit—the capturing unit to the take. I should like to read the last paragraph of Professor Chrystol's letter. He says, "There are many questions to be solved; but they do not seem to be beyond the reach of statistics combined with consideration and intelligent observation controlled by well-directed special experiments. Hasty conclusions and premature application and formulæ are to be earnestly deprecated. All that mathematics can do at this stage is merely to assist the imagination."

1309. We probably all understand after that clear explanation of those curves, that is, when you come to the means of capture, you say, as the efficiency of the means of capture is increased the take will at first increase rapidly, and at the same time the density will also decrease?—But not so rapidly.

1310. But not so rapidly? But then a point will be reached by and bye when both the density of the population of the area and the take will decrease more slowly and in the same proportion?—That exactly expresses it. Now, for this reason you see it seems to me that we should get some indication of diminished density on observations from year to year in that sort of way, that instead of the total take remaining constant or rising that we should get some fall in the total take and some more marked fall in the take per unit. That is my central point.

1311. Would you repeat that? Do I understand you to say that before concluding that the density is diminished you expect to see those results?—I expect to see those results. So far, of course, I have been dealing with the means of forming an opinion as to the deterioration or otherwise in the number of fish. But I think that in order to study the causes producing these variations we have certain means at our disposal which ought to be utilised. I understand, for instance, that certain trawling boats work in fleets, and work more or less in one locality, and that they have a carrier to bring the material to market. Now, it seems to me that the returns which could be made by such a carrier representing a large number of boats would give us very valuable information as regards the distribution of fish, and in the same way, I think, that by subsidising the more intelligent captains of trawlers, and inducing them to keep careful records of the kind and condition of fish taken and the locality in which the fish are taken, and the distances trawled and details of that kind, we should very soon accumulate information which would be of value in gaining knowledge of the distribution of various species, in determining whether the small fish congregate in certain areas, in determining whether the fish spawn in certain localities, and in determining the existence of such local races as Heincke has been able to determine in the herring. By this we could gain from the use of commercial statistics an enormous amount of valuable and fundamental information concerning the fisheries at a comparatively small cost to the country. But I think in investigating the various causes modifying the number and distribution of fish, it is most necessary and desirable to prosecute physical and biological investigation by means of one or more specially equipped steamers, such as were suggested at the Christiania Conference. I cannot help thinking that it was unfortunate that they should have put forward the utilisation of these steamers as the indispensable means of gathering information. To my mind it seems so much more important to get these commercial statistics. To me it seems that the use of the steamer is very much the use of the various scientific workers about which I spoke earlier in my evidence—they should work out special points. For that reason I do not think that those steamers should be utilised in attempting to collect statistics, but I think that they should devote their whole time to scientific investigation.

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1312. You think, as I understand, that any possible number of special steamers could not cover enough ground and produce a sufficient mass of statistics?—I have three reasons for objecting to those specially-equipped steamers being used in trying to get information about the distribution of fish or the improvement of the fisheries; firstly, that the take per trawling unit depends very much upon the number of boats working; secondly, because the area that such a boat could cover in the course of the year is so exceedingly small as compared with the trawlable area of the North Sea; and, thirdly, because it would be a waste of time to utilise a specially equipped boat for gathering information which might just as well be gathered from commercial sources. I think that this boat would have her time very fully occupied in purely scientific investigations, and the investigations which I think should be carried out are, first, investigations into the physical condition of the sea, because the distribution of fish is undoubtedly influenced by the temperature, salinity, supply of oxygen, and by the strength and direction of ocean currents causing movements of the young fish and of the plankton, upon which they feed. I think that the work of Otto Petterson and Ekman shows the importance to the herring fishing of such investigations, and I cannot help thinking that they must also have a very important influence on the recuperative power of any area for ground fish having free swimming and surface swimming young.

1313. You would not agree—we have had some evidence to the effect that hydrographic observations by these steamers would be of little use for national purposes. But as I understand you do not agree with that; it was suggested that it should be left entirely to the cruisers of the Navy, and that the special steamers should be restricted to biological investigations?—Yes. I must say, after reading the work of Petterson and Ekman, it seems to me that it has such a very direct bearing upon the biological work that it would be a pity to dissociate them. Of course, looking at the matter from the point of what, I suppose, is wanted in England, it is rather a knowledge of what measures must be adopted at once in order to preserve the fisheries, and, of course, I think it is quite possible that one may get some knowledge by the use of commercial steamers without the necessity of using such special steamers; but, looking at the question, I think it is absolutely necessary to have such physical investigations of the condition of the sea. Then, secondly, such steamers should be used for biological investigation, observations of the character of the plankton at different seasons, and in different years, and of the reproduction of fish and the distribution of the young, when still too small to be marketable. Even by thus limiting the work to be done I believe it would be found that one steamer could do only a small amount in a year, and that even with active co-operation of ships of other nations engaged in similar work, as suggested in the Christiania Conference, it would take many years before the necessary investigations are completed. I think that it would be impossible for such a ship to devote a sufficient amount of time for trawling purposes, even if it were an economical thing to do, which I greatly doubt.

1314. Are all these the observations you have to make?—Yes.

1315. (*Mr Pelham.*) I understand that you attach great importance to the statistics obtained from trawlers as regards the population of the sea?—I do.

1316. Supposing you obtained certain results we will say in the year 1902 from a particular part of the North Sea, and in 1905 you got returns showing that there was a great increase, or a great diminution in the returns from that particular spot, you would naturally want to know something about the hydrographic condition of that area, would you not?—Not merely of that

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area, but of all surrounding areas—the whole of the North Sea.

1317. I was going to ask you whether there would be any difficulty in working the special steamer in connection with the information that you get from the trawlers?—I do not quite understand the question.

1318. What I meant was this—if you send out a special steamer, and they find out some special fact as regards the population of the sea, and in a particular area, they have also at the same moment acquired information about the temperature of the water, and the plankton and other circumstances, and they would be able to compare that with what they obtained three years later?—I understand quite well now, but it seems to me that in considering a small area one fails to give due consideration to the influences exercised upon that area by remoter parts of the sea, that any change in the distribution of fish might not necessarily be due to the temperature of that particular area but to the changes of the ocean currents in some other part, and for that reason I think a very wide set of observations into the physical conditions of the sea should be made.

1319. You do not think it necessary to connect the physical investigations with the particular trawl, or take of fish?—Not the local physical conditions

1320. Then I take it from the evidence that you have given that you would not attach very much importance to particular trawls taken either by a trading boat or by the special steamer as regards the population of the sea?—I think not. I think it is only by working with very large averages that you can come to any conclusions.

1321. Do you consider that the trawl upon a particular line would be any guide as to what a trawl would be half a mile to the east or west?—So far as I know—I do not consider myself an authority upon fishery matters—we have very little evidence that the character of the fish population in one district represents the character of the fish population in closely adjacent districts, and until we know that, until we know how far the character of the fish population at one point represents the character at the adjacent points, I think that it is an exceedingly dangerous method to take simply a line and trawl along that line.

1322. Now, we have had evidence given of experiments made by the Fishery Board for Scotland, and if I remember rightly a trawl was taken in a particular spot once a month?—Are you referring to the Firth of Forth observations?

1323. Yes, and we have had other proposals of a like nature put before us. Now, supposing a trawl was taken upon a particular spot on the first of March, would an alteration in the take in April or May, or June be of any assistance in forming conclusions?—I would refer you to figures given by Professor M'Intosh in his "Resources of the Sea," where the monthly variations of St. Andrews Bay, and I think in the Forth, are very marked indeed, where one month gives a very small average take, and another a large take. For instance, August gives a very large average take from year to year.

1324. Now, I suppose the take in April one year might vary very much from what was taken in the year before, simply because the season was late or early?—Or on account of other varying physical conditions.

1325. I presume that the currents of the North Sea do vary from year to year—is there much known?—My only knowledge is the work of Petterson and Ekman and some experiments of Dr. Fulton, of floating bottles in the North Sea, where in one year they got a curious reversal of the currents. But, of course, from those with a greater knowledge of oceanic movements than I have you will get more exact information. But both Petersen and Fulton found the same thing in one particular year.

1326. I presume you attach considerable importance to the system of statistics, both as regards sea fish and salmon, being developed and made complete?—I think that is of prime importance. As a member of the Royal Commission on Salmon Fisheries we felt the want of that more than anything else.

1327. Do you consider that the salmon statistics in Scotland are satisfactory?—No, I do not, but the method of taking the amount of salmon carried by rail and steamboat gave us very good approximate ideas of the number of salmon captured

1328. The Fishery Board of Scotland have compulsory powers as regards statistics for sea fish, I understand?—So far as I know that Act of 1885, I think, gives the Fishery Board power to acquire statistics from the captains of trawlers, but how far it is exercised I cannot tell you.

1329. But there is no such power as regards salmon statistics, is that a fact?—There is no such power. The fishermen are generally the tenants of the proprietors, and it is not incumbent upon them to make returns.

1330. (*Mr. Green.*) Do you think that observations taken by a steamer would assist in that part of the calculation that has been left out by Professor Chrystal as to the recuperative power of a certain area?—I should hope that the biological work of such a specially equipped steamer would assist in time in elucidating that point.

1331. In the beginning of your remarks you spoke of an error in the observations made at Grimsby, the Pontoon observations, I think, in Mr. Holt's paper. I was not quite clear that the fallacy you spoke of was in Mr. Holt's figures or in the use that was made of his calculations by a society?—I am very glad to refer to that point again, because what I wanted at the time to emphasise was the importance of properly organised and properly conducted scientific work, and the prevention of mere opinions being put forward in the place of definite scientific data, and I thought that one of the functions of such a central authority as I proposed would be to scrutinise such reports, and to see that matters of opinion were not put forward, and it seemed to me that the sentence "No one conversant with the Grimsby Market will be disposed to say that the subjoined table of proportions is far from the mark," is not based on scientific data.

1332. Do you think that Mr. Holt made observations and published them, and that they could not be described as scientific data?—Well, anyhow there is the table, and there is the statement—there are no data given for that statement.

1333. I cannot remember this article now, but do you not think that he made those calculations according to the classification of fish made in the market on the boxes landed?—I do not know, I have no means of judging that.

1334. He does not state it?—Not so far as I know.

1335. That he took the boxes as classified, and took a percentage of the fish in each of those boxes?—All that I have got to go upon is his statement that "No one conversant with the Grimsby Market will be disposed to say that the subjoined table of proportions is far from the mark."

1336. (*Mr. Spring-Rice.*) On the point of illustrating the sort of evidence you may expect to get, Mr. Holt's statement is put with a rather absurd appearance of figure accuracy, but I understand him to say that no one who knows anything about the Grimsby Market would deny that practically all the plaice landed there are more than eight inches long?—The words are: "Proportion of plaice landed at Grimsby eight inches and above, 99·9 per cent.; less than 8 inches 0·1 per cent."

1337. Of course the percentages are ridiculous, but the fact I should gather from that is that Mr. Holt, who we know worked at Grimsby, and at the same time observed the market, and came across the people who were dealing there, and competent to express the opinion of the market, reported that they said that practically all the plaice landed were more than 8 inches long. Is not that what it comes to?—We are not given the facts to judge of the value of these statements or the data upon which a judgment can be formed.

1338. They do not profess to give that as a matter of accurate experiment, but of observation. I do not want to say whether it is right or wrong, but this is the point: in a question of what there is in the sea, must we not be content to a large extent with whatever valuable information we can get?—That entirely depends upon what you mean by valuable information.

1339. Would you not say that the experience of a number of men who are every day buying and selling the fish would be of some value as regards the practical minimum size?—Well, as a member of the Royal Commission on Salmon Fisheries I have been brought a good deal in contact with those dealing constantly with salmon, and I confess that without having any definite figures given me I consider that their mere

opinion is of no value whatever, and I would greatly deprecate mere matters of opinion having any weight in coming to conclusions for the regulation of fishing questions—I do not care who the authority is.

1340. We have now got your view. But to carry that point further you will not have anything but figured statements—you do not trust anything but figured statements?—I refuse to take another person's judgment without the data upon which that judgment is given being presented to me.

1341. Do you apply the same sceptical view to all conclusions drawn from samples?—Unless the sample has been carefully tested and found to be typical, I refuse to accept it.

1342. To make up your own mind that a sample is typical in any way, whether hydrographical or physical, in the matter of the size of the fish or anything else it is evident that a great quantity of experience is required?—Undoubtedly.

1343. Are we at all near having that sort of quantity of experience with regard to the sea fishery question?—That I cannot tell you, but it seems to me that it must rapidly be obtained by the utilisation of the commercial material which is daily landed in such large quantities.

1344. That is what I wanted to get your view upon, that we want a great deal of preliminary statistical information before we can draw any conclusions?—I think that to draw conclusions, or, still worse, to act upon those conclusions, would be most unwise without definite statistics before one.

1345. In speaking of the scientific work to be done, you put the scientific people rather as advisers than as administrators, I think?—Yes.

1346. You put them as consultants?—I think so, as specialists.

1347. You did say that the scientific people should collect statistics, but you rather meant that they should discuss other people's collections?—Did I say scientific people should collect statistics? I did not mean to say that when I spoke of the collectors of statistics. Were you speaking just now of the Grimsby sea fisheries?

1348. I was going rather to your general remarks?—I thought that the statistics might be collected not by scientific men but by ordinary intelligent men appointed by the ordinary fishery authority, and that the statistics should be dealt with by the fishery authority's advice when necessary by specialists.

1349. You carried that rather far, because you say that even for weighing and measuring you would rather have a man without special scientific training or special views on the subject under discussion?—Yes.

1350. Would you rather have a practical man for that?—Yes, I am speaking from my own experience as regards salmon work.

1351. So far as you have an opinion, that would apply to all these questions of observations and statistics of fish?—To collection of statistics, not of dealing with statistics collected.

1352. How far would that apply to *quasi* scientific observations at sea, say from a special cruiser as to taking the observations?—I do not very clearly understand.

1353. You spoke of, I think, physical and biological observations, the physical observations being such as taking samples of sea water and temperatures, and so on—would you leave that to people without a high scientific training?—I am not speaking as a physicist, because I am not a physicist: but, so far as I know, these measurements require a certain amount of scientific training, and would have to be superintended by a scientific man on board.

1354. Superintended rather than actually carried out?—I think so.

1355. Do you mean on shore or on board?—Speaking in ignorance of physical methods, I should think it would be on board, but I am not a physicist.

1356. But coming to biology, which is more in your line, what would you say in answer to the same question?—There, I believe that on board any special scientific ship fitted up by the nation and worked at scientific work you should have one or more trained biologists, because many of the observations ought to be made upon the fresh material. Much of the material might be collected by intelligent men, properly trained in the work under biologists.

1357. At the same time, would you say that there is a field for the work in a shore laboratory in addition to what can be done on a boat at sea?—Undoubtedly there are hundreds of lines of work which would have to be taken up in shore laboratories, special lines of work in special laboratories.

1358. One other question about the Christiania scheme, which I have no doubt you have read?—Yes.

1359. Have you any general opinion about it?—As to the desirability of investigation?

1360. I am rather assuming that there was to be an international system of working together in the North Sea, and so on; would you say that the Christiania scheme, as formulated in an appendix to their report, was a good one?—Well, I object to it in the first place because they put the utilisation of these special steamers as their first and indispensable point; and, secondly, because I think they somewhat ignore the importance of collecting information about fisheries, and they somewhat magnify the utilisation of investigations which are to be made, which is perhaps natural in the case of the Governments of Norway, Sweden, and Denmark, and other countries involved, who have questions of special interest to them which might be elucidated by investigations in the North Sea, but which are less important in the case of Great Britain, our interests are chiefly to determine the distribution of fish, and that has been left too much out of the consideration of the Christiania Conference.

1361. If the North Sea was an enclosed British sea, and was going to be investigated for the fisheries in which we are interested, you would have recommended a different scheme than that of the Christiania Conference?—Yes; if I had a limited quantity of money to spend, then I should spend it on commercial statistics, and if I had more money, then I would get these specially equipped steamers to work.

1362. Having specially equipped steamers, would you give more prominence to the physical work and call it No. 1, or would you put the biological work as No. 1?—I think that the two are so closely interlaced that it is impossible to dissociate one from the other.

1363. You have no criticism to make from that point of view?—No.

1364. (*Professor Herdman.*) There are just a couple of points I should like to ask you a question or two upon. I do not mean to go again into the instances which you gave of the harm which local investigations might do if not centrally controlled. I do not want to go into the details of that, but I just wish to put to you one point. Do you not think that those were cases where there was control, where the work was done by the investigator under a body, probably as competent to exercise control as any body you could have appointed?—You mean the Association.

1365. In one case the Marine Biological Association?—Yes, and the Scottish Fishery Board. As regards the Marine Biological Association, I confess I do not know how far the governing body of the Association influences the scientific work of the individuals. As regards the Fishery Board for Scotland, I understand, though I have no definite authority for it, that it is left very much in the hands of the scientific adviser.

1366. Still, there was some control in each case. There was a council in one case composed of scientific men, and in the other case there was a board?—May I take it from you there was the control of that council in the case of the Marine Biological Association?

1367. You must not take it that I know the details of the control. I happen to be on the Council myself, but I am not saying that they exercised any detailed control. Still, the work was done by an investigator under the control of a higher body?—I take it from you, of course.

1368. That was one point; then the other point I wish to put to you is more with regard to the general principle. Do you not think there is some danger of choking local effort, of preventing much useful work being done, if you put everything under the control of a central board?—I do not think so. I think if the central board takes an intelligent view of the situation it will see upon what questions local effort could help it. For instance, take that question which I alluded to, the food stuff of the young of salmon in rivers; that is a matter which wants investigation just now, and I should think a central board could get very useful work out of local naturalist societies, and so on, upon such a subject; and similarly upon fishery questions I think

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very valuable work upon special subjects might be got out of these local bodies and local workers.

1369. Do you not think there is also a risk of there being valuable work which might be done by local bodies, say, at marine biological stations, where that work would not be done if controlled by a central authority—would not the workers object to be under control?—But you never can control these purely local authorities, these purely local workers. They will go on doing their work in the same way, but they will not be subsidised by the central authority unless they are working for it.

1370. You say you never can control them; in that case, do you mean you would not subsidise them?—You would not subsidise them; you would not pay for the work being done there unless the work was done in accordance with a big scheme and could be standardised, as it were, made comparable with the work done in other places. As you know the trouble with all scientific work is that one man works with one method, and another with another, and the results attained are often very difficult to compare.

1371. Do you not think a consultation between local bodies might effect that—I agree with you—desirable end?—I think a consultation between local bodies and a central authority would be even more useful.

1372. I think I have got your opinion upon that?—Yes.

1373. Then another point to which I wish to go is this: I understood you to say that you do not consider it necessary to connect the local physical conditions—we are now talking of work at sea—with the takes of fish at a particular time or on a particular ground, the takes of fish that you are going to ascertain from the commercial trawlers; am I right in thinking that is your opinion?—No, I think you probably do not quite represent my views. What I rather meant to indicate was that not merely the local conditions, but also physical conditions at a considerable distance from the locality, might have an important influence, and if you consider the local conditions only, neglecting the conditions at a distance, you might be led to erroneous conclusions.

1374. But nobody would propose to neglect the more distant physical conditions; the point rather was whether you were to take the local conditions, and I understood you to say that it was not necessary to get the local conditions?—Not speaking as an expert on fishery questions, I say that, without considering the conditions in the surrounding areas, to take the local conditions would be dangerous.

1375. Yes, but you would consider it necessary to take simultaneously your physical conditions when you take the fish?—At the same locality.

1376. The same locality and the same time?—I would go further and also study the physical conditions round about.

1377. But the scheme you put before us would not give you that; it would not give the physical conditions along with the take of fish. You get the take of fish from the commercial trawlers and your physical conditions would be got by special boats?—The physical observations should be made as extensive as possible in order to make them bear upon the takes of trawlers, and for that reason I thought the scientific boat should devote itself very largely to those scientific aspects because it is so important to have them over a large area.

1378. It is a question of what you mean by "as extensive as possible"; can they be as extensive as the operations of the trawling fleet?—It is all a matter of expense—if you like to pay for it.

1379. On the Christiania scheme they would not be as extensive?—Obviously, the boat would take years and years to co-ordinate the physical observations with the takes of trawlers, at least in my judgment.

1380. Now take such a fish, for example, as plaice, which is of very great importance; do you not think that it is influenced not so much by these physical conditions which we are talking of, such as temperature and salinity—comparatively small changes in temperature and salinity—as by the nature of the ground and the food on the ground?—I have no information on that subject—I have no knowledge of that subject.

1381. Supposing it were so, that plaice was more influenced by the nature of the ground and the food on the ground, does it not seem that, according to the scheme you laid before us, you would miss altogether the class of observations, or information, that we require? The class would neither come under the hydrographic observations nor yet be got from the commercial trawlers?—It depends largely upon the food.

1382. I mean such observations as one would get by a biologically equipped boat, trawling and using different kinds of instruments, such as dredgers, and getting up considerable quantities from the bottom, and of the animals living in the bottom, material upon which the plaice, for example, feeds, material which is never brought up by the trawler's net?—I think that material is largely brought up by the stomachs of the plaice.

1383. It is to some extent; you think that is sufficient?—It seems to me it gives you very fair indication of what is the food of the plaice at any particular locality.

1384. And you do not want to know where that food is on the bottom?—I do not wish to be misunderstood in that matter. I perfectly recognise the advantage of very extensive biological investigations, and I should like to see any number of steamers specially equipped for such work, but I am considering the probability of the British Treasury expending money upon such investigations, and it seems to me that the method of spending money which I suggest would more readily give the results than spending it simply upon steamers for scientific work.

1385. Then you went on to deal with certain steamers for scientific work, namely, those which are going to take hydrographic observations?—And biological observations.

1386. I did not understand you to mean that those steamers would take dredgings?—I do not think you can carry on biological observation without tow-nettings and dredging and all sorts of methods.

1387. I am glad I have got that from you. You implied that?—I think I said that quite distinctly.

1388. I thought you spoke of hydrographic observations?—I said that observations should be carried on as to the character and plankton at different seasons and in different areas, and of the reproduction of fish and the distribution of the young while still too small to be marketable.

1389. Do you add dredging, because it is not in that statement—bottom work?—Certainly, bottom work.

1390. (*Mr. Archer.*) I understand that your reference to Mr. Holt's paper this morning was simply given as an indication of the need of central control?—Yes, of central control and central revisal of returns.

1391. I should not refer to it again had it not been that I think the slight confusion which arose this morning was on account of a confusion in dates. You meant to refer to the Committee of 1900 as the Committee before which Mr. Holt's investigations were made use of, and not to the Committee of 1893?—No, I think, if I am right, that the evidence of Mr. Towse was given before the Committee of 1893, representing the ideas of the Grimsby and Hull Association.

1392. But that simply had reference to the area in which the trade desired to have a playground or enclosed area?—That is so. And then came these observations on the 13 hauls of the trawl, made in a district which was not included in the area, but the results of which I understood had been used subsequently as evidence of the size of fish in that area, and to support the contention that a certain area in the eastern part of the North Sea should be protected.

1393. Quite so, but the subsequent occasion upon which they were used was not before the Committee of 1893, but before the Committee of 1900?—I am wrong about the Committee of 1893. It was then that the representation of the Grimsby and Hull trawlers was brought forward by Mr. Towse.

1394. Yes, I only just wanted to clear up that point. Then the Chairman asked you if the remarks you were making with regard to the average take per bag net were based upon theory or on the result of experience?—Yes. You have, of course, experiments which you know very well in Norway, recorded in the 39th annual report of the Fishery Board for England and Wales, in which so far as I remember just now, you showed that in the first period the take per net, and the total take, increases, and in the later period the total take goes on increasing or remains constant, and the take per bag net diminishes.

1395. Yes?—While at the same time the take of salmon in the rivers, that is, salmon which have passed

tha bag nets, has not fallen, showing pretty clearly, I think, that the density of the salmon has not decreased, although the take by the bag net has decreased.

1396. Quite so?—I think that will be considered a sort of experimental basis if you like for my contention, and I say further that it is founded upon the assumption of a comparatively equal density along the coast, and the method of migrating along the coast.

1397. Then you refer to the collection of material at ports of landing and to the collection of material by special steamers, but you made no reference to the question of placing experts on board the commercial trawlers for obtaining such material?—Experts on board the commercial trawlers?

1398. Yes, on board the commercial trawlers?—But before considering that question one has to consider to what extent it is contemplated to put experts on board. It seems to me that introduces a very great difficulty, to provide a sufficient number of experts to get anything like reliable results, because it is not as if these commercial trawlers would trawl at definite points, such as would be required to give anything like a sequence of observations to be of any value, but they will go on trawling at all sorts of places and you will get a mass of statistics which it will be very difficult to make use of. It seems to me that the money might be more advantageously spent in some other way than by putting experts on board trawlers.

1399. In fact, you would get a mass of isolated observations which would be of very little use?—Yes. I do not think it would help this scheme to work by commercial trawlers; at least I should not think it would be possible.

1400. (*Professor Thomson.*) Just one question as a matter of accuracy. In illustrating what might be got out of commercial statistics, you mentioned such work as Heincke's "Varieties of the Herring." As you are aware, that is a very profound and subtle biological work. How it could be got out of commercial statistics entirely passes my imagination?—I think possibly I might not have made my view quite clear. When I cited Heincke's work I was talking of the information and of the material to be collected from many localities by selected boats, boats with particularly intelligent skippers, who would be paid for collecting the material and for noting the locality of the material. That material would be placed at the disposal of biologists for further study. *Dr. Neil Paton.* 4 Dec. 1901.

1401. Heincke's book is not based upon such data at all?—Heincke's work, so far as I know it from Fulton's translation in the reports of the Scotish Fishery Board, was based on measurements, counting the number of vertebræ, and so on, of herring obtained from different parts of the North Sea at different periods. I think I am right in that.

1402. He took forty measurements of the different organs of the herring over a large series of specimens, and based his results on those forty different measurements. My whole point is that it is a kind of work of great use, but of such delicacy and subtlety that it could not possibly be done except by a man trained in such methods?—I thoroughly agree with you. But what I maintain is that the material for such work could be got from commercial fisheries.

1403. You mean the raw material?—Yes, the raw material.

Mr. F. G. Aflalo, called; and Examined.

1404. (*Mr. Crawford.*) Mr. Aflalo, I believe you have written several books on sea fishing as a sport?—Yes, I have. *Mr. G. Aflalo.*

1405. And you took a leading part in founding the British Sea Anglers' Society in 1893?—Yes.

1406. You were the founder of it?—Yes.

1407. It is now about 800 strong?—Yes.

1408. You gave evidence on German fisheries before Mr. Majoribanks's Committee, now Lord Tweedmouth?—Yes.

1409. I understand that you have studied the local sea fisheries in various parts of the British Isles?—Yes, I think I may say that.

1410. In the Western Baltic and the Mediterranean?—Yes.

1411. And in parts of the French and Spanish coasts?—Yes.

1412. And at every port but one in Morocco, and in all the colonies but one of Australia?—Yes, except Western Australia. When I say I have studied them, it is in a more or less passing way. I have interested myself in them.

1413. Have you formed any opinion as to what the nature of the fishery authority ought to be?—So far as its centralisation goes, do you mean?

1414. Yes?—I have formed the opinion that until you centralise it you will never get any direct benefit, because I have always found these local authorities are thought nothing of in their own district, absolutely. If I may explain it, I mean this. I approach this subject of course not in a scientific spirit as many of your witnesses do, as Sir Herbert Maxwell would be aware, but I am living on the coast the whole year and fishing the whole year, and I mix a great deal with fishermen. If I may say so, with all respect, perhaps I get a little more direct evidence from the fishermen than anyone official would get, because they do not regard me with that suspicion with which they always regard an official, even against their own advantage. A body, for instance, like the Marine Biological Association, is known a great deal of from perhaps Looe on the west up to—I do not like to assign an eastern limit—some not very remote point east of Plymouth. But when you get east or west of those limits you never hear anything of it at all; none of the fishermen, and no one can give you any information. I am not saying that against the Marine Biological Association, but until you have a central authority to collate your evidences, and put them to central use, you will never get any influence to bear upon the problem at all.

1415. You think there ought to be a recognised authority?—I think so, yes.

1416. Have you considered at all what the position of such an authority ought to be, whether it ought to be a separate department, or whether it ought to be subordinated to one of the great public departments?—Personally, I would rather see it separate, because it seems to me that there is an example in other countries where there is a separate board, either Woods and Forests, or Fisheries, or Forest and Fish Commission, as in the States. It does not seem to me to form part of the work of any other public department, even if that other department is entirely satisfactory in conducting it, which I am not prepared, perhaps, to admit.

1417. I gather from the notes which you have been good enough to furnish us with, that you would compare it to the position of the Board of Agriculture or the Woods and Forests?—I ventured to institute that comparison without the basis of much knowledge of what position they actually occupy; it simply struck me as an analogy.

1418. The subject which particularly concerns us as a Committee is the duties of such a central authority with regard to research?—Quite so. I think I rather misunderstood the reference of the Committee there, but if I may say so, to myself, fishing and mixing with fishermen, that seems to be only one of many important issues, unless your scientific research would carry you to such questions as the closing of in-shore areas—I mean quite apart from biological investigation, because to me there are sides of that question with which biological investigation has nothing whatever to do.

1419. The theory is that research would give the requisite information?—That is the accepted theory, yes.

1420. Have you anything to suggest as to the constitution of such a fishery authority?—Of course, if you are confining your reference to scientific research, I suppose it would be simply a committee of biological experts, with a certain number of officials, but I took a broader view of it. I think there is a scientific side of what you want to get at, and an economic side, and a side which may be distinguished from both of those; I think you want to take into consideration the opinions of the fishermen themselves, and those

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opinions are never taken properly into consideration at all. It would be taking up your time uselessly to specify them, but I have known cases in which experts—against whom I have nothing personally, I have not known them—have lectured the fishermen and got their opinions, and taken absolutely no notice of them; they have given the men the trouble of giving their views, and I have never even heard that those views have been put before such a central authority as there is, such as the Fishery Department of the Board of Trade, so far as I am aware.

1421. Assuming the authority for research was the same as the administrative authority generally, how would you suggest that the voice of the fishermen should be heard and represented?—Simply in this way. I think such a central board ought to have one or two inspectors, or three or four if necessary, who would more or less be permanently at the coast, and not in London at all, because after all in London you can only make use of the evidence; you cannot collect it. These men should each have a distinct district, one the south coast and another the east coast, and they should make it their business at certain periods of the year to go round those various ports to hear exactly what was going on, and take account of the catches, and try to get a proper return of statistics. They should not get it, as the Board of Trade gets it at present, through the coastguardsmen. That is one of the things to which I venture to take the greatest exception, because I myself went round all the fishery ports of Cornwall and Devon this summer for a London paper—it was, of course, an unimportant thing, and I only mention it for this purpose—and at every place I went to the harbour-master got me the returns of the fish, which had been collected by coastguardsmen. But coastguardsmen, when they enter the service, do not know the three different kinds of flat fish, one from the other. they simply have to take the thing in a perfunctory way. I think, on the other hand, if an intelligent man who understood these things went round and collected this information he would get at the truth: he would know how to present that truth, and would be in constant touch with the Central Board. I do not think that such an official would be a great charge to the department, because he would only make two or three tours of investigation, and would be paid for them; I do not regard him as a permanent salaried official at all. Possibly three or even six times a year he would be called upon to devote a fortnight or three weeks to going round and collecting information, and in the intervening period I take it he would have his own occupation, which would not be interfered with. That is only one instance I give. Of course there is no such recognised official at present, but the circumstances of the case are somewhat different.

1422. I gather that you would rather prefer the system which the Fishery Board has in Scotland, where they have a fishery officer in each district?—Certainly.

1423. And when there are complaints or petitions by the fishermen it is his business to see them?—Quite so.

1424. I see there is a good deal in the notes which you have given us which do go somewhat beyond the reference?—I fear that is so. I made out those heads somewhat hurriedly.

1425. I think they are extremely clear, but they really go beyond the subject of the research which is given to us?—Quite so.

1426. When you arrive at your conclusions, I see that you touch on this question. When you suggest a certain central board, do you mean a central board for the United Kingdom, or would you prefer that there should be a separate board for Scotland and Ireland?—Upon that I do not feel competent to give an opinion. It merely struck me it might be a delicate matter suddenly to supersede the Scottish Fishery Board which seems to have done the only good work of the kind which has been done. I do not know how far it would be possible without friction to supersede that Board, but if it could be done I suppose the ideal arrangement would be a central board for the whole kingdom, because the fisheries of the whole kingdom come to all manner of ports. It is not easy to dissever the Scottish fishery interest from the English or the Irish. I merely thought there might be difficulties.

1427. Will you give us your views as to the duties of the Fishery Board?—This Board of Fisheries, independent of any other public department, would take cognisance of all fishery disputes and of the necessary measures for protecting both river and sea fish. It would devise and control a more efficient system of collecting and publishing statistics than that at present in use. It would study and report to Parliament upon the actual damage done by trawling, and the measures that, in its opinion, would best meet the case. It would encourage useful inventions bearing on the trawl and on the transport of fish from the more distant grounds. It would study and report upon the migrations of important fishes, making known the results of its investigations to both Parliament and the fishermen of the districts concerned. It would study and report upon the question of porpoises, sea birds, and seals in the light of vermin, and the extent to which active or passive measures—that is, a premium on destruction, or a withdrawal of prohibitive legislation such as the Wild Birds' Protection Act—would combat the difficulty. It would be composed of men capable of studying these many problems from every standpoint, the biological, the economic, and what may, perhaps, for want of a better term, be called the general standpoint. "General" is an extremely poor word, but I cannot think of another. In short, science, commerce, and common sense, unbiassed with the theories of either, would combine to work out these problems as they are successfully doing in America.

1428. I suppose you have not had occasion—you do not mention it in your notes, at least—to consider the question of an international scheme for making scientific investigation?—I have very often considered it in connection with letters I have had from Professor Heincke, and so on, and documents which I have seen from Sweden. I have a friend in Sweden who sends me these papers. It seems to me only an added reason for a central board. I think, before you can carry out these international negotiations, you want a central fishery board, as I understand these other countries have. Of course, I do not say it out of any want of respect for the Board of Trade, but it seems to me the other countries will think it strange that, while they have a Department specially for fisheries, the one country which has the largest stake in the fisheries relegates them to a small sub-department of a general Trade Department. I have considered that, and I take it as one of the grounds for the establishment of a central board, merely in the way that a Sovereign has a number of ambassadors to put him on equal footing with other Courts.

1429. (*Mr. Pelham.*) With regard to the statistics, I do not understand how you would collect them. You do not wish the coastguardmen to collect them?—No.

1430. Whom would you have at each port to do it?—I do not think I would have anyone at each port. I do not think you want to know from day to day how many fish are brought in. I think you want to take certain stated periods in winter and summer, and get an idea from the returns more or less accurate—more accurate, if possible—of where these fish were brought from. I think travelling inspectors at certain times could do the work much more efficiently. I mean a man who knows one fish from another, at any rate, and who would have some idea of the leading questions to put to skippers of trawlers and so forth, which the coastguardsmen cannot possibly have.

1431. But his knowing a fish by sight would not help him very much with regard to the fish which were landed a week before he arrived there, would it?—No. The statistics to which I refer are not wanted every week, I think. I think one wants them at certain periods. It is not the number of fish but the size of the fish brought from each ground about which information is desired, because that affects the all-important question of declining on the closing of in-shore areas. I was at Brixham in the summer; I constantly go there, and one particular fish dealer, who is much less unintelligent than the rest, gives me a good deal of information, but the most difficult thing to get at is where those different classes of plaice and soles come from. Some come from quite near shore; others seem to be trawled down near the Bay of Biscay. I think that is what one wants to get at.

1432. Do you think it would be easy for a man to find out this information by only visiting a port three or four times a year?—I think so, yes. I cannot see any obstacle. He would only find out information as applied to a certain batch of fish. These drawlers are away for a considerable time, for a week or two weeks. He would meet these men as they come in from their trips, and I think on the basis of, say, three or four

such trawling results in the year, properly done, you would have far more satisfactory grounds of legislating or advising legislation than a coastguardman's returns for every night of the year. I cannot conceive of anyone less qualified than a coastguardsman to collect these figures, except that he costs nothing.

1433. The coastguardsman will get them from the trawler first hand when he has the subject fresh in his memory, whereas your visitor would have to take not only second hand, but would have to trust to the memory of the skippers as to what took place on the previous days?—That is all the coastguardsman can do, because the trawler does not on his more important excursions go out for one night only.

1434. The coastguardsman can see him every time he comes in?—Quite so, and the skilled inspector would see him on four occasions on which he came in, and I think he would get much more accurate information on those four occasions than the coastguardsman would in a hundred.

1435. Would you apply such a system to such large places as Hull and Grimsby?—I think so, yes.

1436. Do you not think it would be a better system to have a paid collector on the spot, and possibly have a skilled inspector paying a visit every few months?—Oh, quite so; that is, if you allow me to assume that the paid collector would be somewhat more capable of fulfilling those duties than a coastguardsman, unless of course the coastguardsman has had special instruction. I do not think the coastguardsman's official qualifications include any of the requisite knowledge—it may not be very much, but he should have some idea of the thing, of the methods of fishing, the species and varieties of fish, and so on.

1437. Perhaps you do not know the number of places where fish are landed in England?—I think I have some idea, that is, if you mean important places.

1438. I mean statistics are obtained now from 157 different ports in England and Wales alone?—I know that. I have the pleasure of receiving from the Board of Trade every Blue-book and every report—I think Mr. Fryer sends them to me—so that I do not speak quite without knowledge.

1439. (*Mr. Spring-Rice.*) You know a great many fishermen very intimately?—Yes, because I am always among them.

1440. Have you ever been able to suggest any way of discriminating between the kind of information upon which their opinion is of value, and that where it is of no value?—Certainly. I think with regard to most of your biological investigations they would simply have superstitions. I take it you would not take the evidence of fishermen on the food of fish at certain seasons, because, as a rule, with very few exceptions, they would give you all sorts of mythical stories. There are exceptions. There was a man, Matthias Dunn, who was a fisherman and an extremely clever man as well, but he lately died. I think you might take the opinion of fishermen as to the class of fish taken on different grounds at different seasons of the year more than is done now.

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1441. Do you think they would tell one that?—I think so. They have always told me. I do not know whether an official, going as an official, would get the information. That is the danger. They are always suspicious.

1442. Take the Brixham fleet, and take the point which you describe very clearly, that the fish would be divided into classes, one of which would come from one part of the sea and another from another: do you think it would be possible to get from the skippers of the Brixham fleet information on that subject which would be of real value?—I feel quite sure of it, because I cannot see that they have any interest in concealing it. But I do not think a coastguardsmen would put a leading question to elicit such information.

1443. I was not suggesting a coastguardsmen. If they were asked do you think they would give the information?—Yes, I think so.

1444. You are aware the money question would come in. I mean a man would not like to tell you where he had made a good haul for fear of its reaching his rivals?—He would give you a rough idea of how far from shore it was that he trawled, and where he got the greater proportion of the matured fish.

1445. Take that a step further: would he tell you where he got the greatest proportion of immature fish?—I am not speaking of biologically mature fish; I was speaking of their size.

1446. If they told you that from a certain region of the sea you never got any plaice eight inches long, you would attach importance to that?—I think so.

1447. Would you believe it on the whole?—I think so, yes, not seeing any interest for the man to lead you wrong. I think from my knowledge of the men I would believe it; yes. I should have no reason to disbelieve it.

1448. (*Professor Thomson.*) I should like to ask you one question. Do you not think you made a somewhat strong and unwarrantable statement when you said that no good work had been done except by the Scottish Fishery Board? Have you forgotten altogether the work done by the Liverpool Marine Biological Committee, and the Association at Plymouth and so on?—I know the Plymouth Association, and I have every regard for the courtesy and intelligence of its officials, and, within its admittedly scientific limits, every appreciation of its work, but I thought the work was slightly different. I thought the work was purely biological at Plymouth, while the work of the Scottish Board was administrative. I was not referring to scientific work, but to administrative work.

1449. I do not think that was quite clear?—Perhaps it was not, but that was my meaning.

SIXTH DAY.

Thursday, 5th December, 1901.

PRESENT:

DONALD CRAWFORD, Esq. (in the Chair).

WALTER E. ARCHER, Esq.
The Rev. WILLIAM SPOTSWOOD GREEN.
Professor WILLIAM ABBOTT HERDMAN, F.R.S.
The Hon. THOMAS H. W. PELHAM.
STEPHEN E. SPRING-RICE, Esq., C.B.
Professor J. ARTHUR THOMSON.

R. E. MARTYR, Esq., *Secretary*.

Mr. WALTER E. ARCHER, called; and Examined.

1450. (*Mr. Crawford.*) You are Chief Inspector of Fisheries to the Board of Trade, and a member of this Committee?—I am.

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1451. And you have furnished us with a statement of the evidence that you intend to give. How would you divide it?—I divide it under five heads. First, the duties of inspectors; secondly, the reference to my being sent to the Stockholm Conference; thirdly, the object of the investigations proposed at that Conference, which I divide under two heads, hydrographical and biological; fourthly, the method of investigation which is divided hydrographically and biologically; and, fifthly, for the sake of clearness I sum up the conclusions to which the facts which I shall put forward seem to lead.

1452. I presume that your statement of the duties of

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inspectors, as you describe it, will practically give us the form of the administration of the Fishery Department of the Board of Trade, will it not?—No. I have not specified all the duties of the inspectors, only those which more particularly involve ichthyological research.

1453. Under what Act are the duties of the inspectors regulated?—Under Sections 31 and 32 of the Salmon Fishery Act of 1861 as amended by Sections 3 and 6 of the Salmon and Freshwater Act of 1886.

1454. How many inspectors are there?—Three.

1455. Including the Chief Inspector?—Yes.

1456. Are their duties locally delimited, or do they go down to any part of England?—They go down to any part of England and Wales.

1457. Including the Chief Inspector?—Yes.

1458. Would you state what their duties are?—They involve the preparation of annual reports containing, as far as may be practicable, a statistical account of the salmon, fresh water, and sea fisheries, with such other information as may be collected, with suggestions for their regulation and improvement. The duties assigned to them by the Board of Trade have, in addition to inspections and other duties, included that of advising the Department in the matter of bye-laws submitted for their approval by local committees of sea fisheries and salmon Boards of Conservators, such bye-laws not coming into operation until confirmed by the Board of Trade.

1459. And those duties involve ichthyological research among other things?—Necessarily, but no money is voted for this purpose at present.

1460. When you speak of your annual report, does each inspector make one, or do they make a joint report?—We now make a joint report.

1461. And it was separate until two or three years ago?—Yes.

1462. And in a very general way, would you indicate to us what those reports contain? I presume they contain the report of any inspections that you have had to make?—Yes. We refer to inspections in the reports, but we endeavour to frame them as far as possible in the manner prescribed in the Act.

1463. It is prescribed under the Act, then?—The Act particularly provides that the reports shall contain as far as possible a statistical account of the fisheries with such information as may be collected, with suggestions for their regulation and improvement. We have considerable difficulty in making suggestions for their regulation and improvement owing to the want of means to collect the necessary information, but as far as we can we try to put forward facts which may be of value in that direction.

1464. Then, is there one of the principal officers of the Board of Trade especially charged with this department of the work of the Board—one of the assistant secretaries?—In charge of the Fishery Department?

1465. Yes?—Yes.

1466. Is there any other subject included in his department?—Yes.

1467. What is the name of that department?—The Fisheries and Harbour Department.

1468. Have you anything more to say upon the subject of inspectors?—I do not think so.

1469. Then we shall pass to the subject of the Stockholm Conference. What have you to say upon that?—I attended the Stockholm Conference in 1899, but not the Conference in Christiania in 1901; the latter was originally fixed for the same day as the first meeting in Scotland of the Royal Commission on Salmon Fisheries and, in deference to Lord Elgin's wishes, the Board of Trade excused my attendance at that Conference.

1470. Then you come next to the object of the investigations proposed at that Conference?—Yes.

1471. What have you to say?—The object of the hydrographic investigations is to ascertain the physical conditions under which fish live in the sea, and the effect of the ocean currents on the climate of western Europe. With the latter object we have nothing to do, but to those countries bordering on the Skagerack and Baltic it is probably the more important object of the two, since it is anticipated that a thorough knowledge of the hydrographic conditions of the North Sea and North Atlantic will make it possible to determine whether the winter will be mild or severe, and when ice is likely to form. It is, however, also considered that the sudden appearance and disappearance of fish from time to time and place to place, which is so marked a feature in fishing, is due to changes in the physical conditions. Temperature, salinity and oxygen, it is thought, may determine the growth of food, ocean currents its distribution and the distribution of the pelagic eggs and larvæ. Without a knowledge of these currents and conditions it is impossible to determine to what extent the variations in the abundance of fish from time to time or place to place is due to natural causes, and how far it is due to the operations of man. And I propose, as an example of these fluctuations, to refer to the enormous number of haddocks which appeared in the Firth of Forth in the years 1893, 1894, and 1895, and of whiting in 1890.

1472. You have prepared a chart illustrating these?—Yes, I have. This chart (Chart I.) illustrates the number of plaice, common dabs, haddock, and whiting caught in the experimental fishings of the "Garland" in the Firth of Forth. The quantities have been reduced to the average take per mile trawled over, so as to make them comparable, and appear to me of considerable value in this respect that, as I shall have occasion to describe later on, the amount of fishing in each year is practically the same, and the area is closed to other trawlers, consequently the sudden fluctuations are presumably not caused by the operations of man.

1473. You propose to go more fully into the chart later on?—No; I propose to go into it now. It will be seen that the average take of haddock—which is illustrated by the dotted red line—was five times greater in 1893, 1894, and 1895, than in the four previous years, showing the difficulty simply from statistics of the take of fish of comparing the effect of measures taken for the improvement of the fisheries without a knowledge of the natural causes which influence the distribution of fish in different seasons. With regard to whiting you see that three times the quantity are caught in 1890 than in any of the five subsequent years, showing that the inclusion or exclusion of the yield of 1890 from any one period, without a knowledge of the causes which led to the large yield of that year, would materially influence any deductions which might be drawn from statistics alone.

1474. (*Mr. Pelham.*) Is that haddock?—I am not describing whiting—whiting are shown by the black-dotted line. We then come to flat fish, plaice, and common dabs. I think these curves are particularly noteworthy. They show that in the case of plaice and common dabs there is not the same fluctuation as there is in that of haddock and whiting, seeming to indicate that possibly the hydrographic conditions do not exercise so much effect upon the flat fish (in which we are particularly interested in England) as they do upon round fish.

1475. (*Mr. Crawford.*) Is it the case that the flat fish do not move about so much as the round fish?—It is believed that that is the case. But as I shall show later on that there is apparently a to-and-fro movement of the flat fish from the outer waters to the inner waters.

1476. Then you proceed, I think, to explain the hydrographic scheme that is proposed by the Stockholm Conference?—Yes. The hydrographic scheme, I understand, is founded on the theory alleged to have been established by Petterson, Ekman, and others in the years 1893–1899, that the waters which enter the North Sea area are derived from three different sources, namely the Atlantic, the Arctic, and the Baltic; that each of these currents have a different degree of salinity and temperature; and that the hydrographic condition of the North Sea therefore, is liable to great changes from season to season, and from year to year, according to whether one or other of the currents are predominant.

1477. And then as to the biological investigations, what have you to say?—The object of the biological investigations is to determine the fluctuations in the abundance, description, size, and sexual ripeness of fish taken on the same and different grounds at the same and different seasons of the year, and some of the causes affecting these fluctuations with the view of ascertaining whether the fishings are falling off, and, if so how, where and when protection can be applied.

1478. And what are the methods proposed to investigate those two subjects?—At the Stockholm Conference it was proposed to investigate the hydrographical conditions by means of observations taken on board special steamers, light ships, mail steamers, and any other available means, but the method by which the biological problems were to be investigated was purposely not laid down.

1479. I understand that you propose to consider independently what would be the best means of investigating those two subjects?—Yes, that is so.

1480. Will you give us your opinion about that?—It appears to me that the hydrographical investigations must necessarily be conducted by means of special steamers, as it is only by this means that it would be possible to make periodic observations on the lines recommended by the Christiania Conference. In saying this I do not wish to say that it is necessarily limited to special steamers, but that special steamers will be required.

1481. You are speaking just now of the hydrographic investigation?—Yes, the number of steamers it seems to me will depend on the extent of ground to be covered, the number of samples to be taken, and the time occupied in obtaining the different samples. These are questions for a hydrographer, but care must be taken that the samples are representative.

1482. When you say samples there, I presume you mean samples of water and plankton, and not samples of fish?—Yes, samples of water and plankton. When I say that the samples should be representative I think perhaps I might illustrate my meaning more clearly by reference to this chart, which is appended to Dr. Hjort's report of the investigations which he made in the "Michael Sars" in 1900. This chart illustrates the salinity and the temperature of a certain area of the North Atlantic visited by the "Michael Sars." The salinity is shown by different shades of green and blue; temperature by figures placed against red dotted lines; and the steamer's route by a thick black line.

1483. That chart covers a large area between Iceland and the North of Norway?—Yes, the steamer apparently proceeded from somewhere near Florö on the Norwegian coast to the north of Iceland, thence to Jan Mayen, and from there to the North of Norway.

1484. Does the deep blue line indicate intense salinity?—Yes.

1485. There seems to be the most marvellous difference between the different parts of that area?—Yes. But for the moment the special point to which I wish to draw attention is that observations taken by Dr. Hjort whilst crossing the ocean twice at widely different points, seem to have enabled him to lay down the physical conditions of the water in the intermediate area. If that is so, a point on which I am not prepared to express any opinion whatever, it shows that special steamers might be of very great value for this work. But I think before accepting this conclusion we require to know the basis on which the salinity and temperature has been calculated in that part of the sea which apparently has not been visited by the steamer.

1486. Apparently the theory of the chart is that he makes one voyage at the extreme south of the ground, and the other at the extreme north, ending in Iceland?—Yes.

1487. Across a very broad zone of intense salinity practically of the same breadth in both voyages?—Yes.

1488. And then he assumes that the zone stretches from the north to the south?—That seems the apparent explanation.

1489. How are the temperatures marked?—The temperatures are marked by red dotted lines, which apparently are also crossed at different points.

1490. Do those temperatures correspond in the same longitude in the same way as the salinity does?—Apparently not.

1491. I confess that this chart is an exceedingly difficult one for me to understand. I do not understand how it is that these different curves and colourations are given. (*Mr. Spring-Rice.*) Those are assumptions?—I cannot express any opinion, because I do not know the basis on which the illustrations are made. I am simply putting it forward because I think it affords an illustration of the need of getting further information on this subject. With reference to the same subject I might also show this chart which accompanies the Reports of Messrs. Petterson and Ekman, to which I have already referred. You will see that in December, 1896, the Atlantic current broke through the other layers between Hanstholmen and the Scaw. This current has apparently broken through *there*. There is nothing that I can see in the chart which accompanies Dr. Hjort's Report to show that this may not have occurred in the area where there are no observations.

1492. (*Mr. Crawford.*) The colourings are a little different, but do they mean substantially the same thing—the deepest blue means salinity?—Yes, I understand that the deepest blue means the greatest salinity.

1493. These investigators must have made more voyages?—Yes, they made many more voyages. You will see on the bottom of the chart the routes along which they made their investigations.

1494. Where is that? I cannot see that?—I think I can show it to you (*pointing it out on the chart*).

1495. Here we have the Swedish lines—does that mean lines of route?—Yes, lines of route.

1496. Is that all you have to say as to hydrographical investigation?—Yes.

1497. Now what have you to say as to the biological investigation?—There are three methods by which it is proposed that the biological observations may be made; first, by special steamers making periodic surveys; second, by sending competent experts on board fishing vessels; and, third, by the examination of the fish at the port of landing.

1498. How was that dealt with at the Stockholm Conference?—At the Stockholm Conference it was felt that neither the time which the majority of delegates were disposed to give to the matter, nor the information at their disposal, was sufficient to enable a detailed programme to be elaborated, and that this work could be better done by the International Council with the assistance of a staff of salaried officials. I do not mean to say that that was the officially expressed opinion, but there was a feeling amongst some of the delegates that that was the case, and that it was premature for us there and then, only meeting together for a week, to approach such an extremely difficult and intricate subject as that of laying down the actual method of investigation.

1499. You consider that the circumstances in which you met in that way account for the fact that a detailed biological programme was not put forward?—Yes.

1500. The subject, however, of special steamers—that is dealt with, is it not, by the Christiania Conference?—Yes. At the Christiania Conference the three methods are referred to, but beyond the minimum requirement of one steamer for each country, the extent to which each method should be employed is not specified. The first method appeared to be that which commended itself most to the Christiania Conference since the acquisition of a special steamer by each country is the only indispensable requirement which they lay down. The two other methods are optional. The same method seems also to be that on which the Danish, Swedish, and Norwegian authorities principally rely for carrying out their part of the investigation recommended by the Conference.

1501. Are you aware if at present any of these countries have adopted the second and third methods at all?—As far as I am aware they have not. In the Danish scheme it is proposed that the biological director should arrange to hire vessels, or a vessel—I am not sure for the moment which it is—but as far as I can see no provision is made in the estimate for the cost of hiring such vessels. In Sweden I understand they propose to do the work by the special steamer with the assistance of fishing boats, that is to say that the steamer is to tow a fully-equipped fishing boat to the nearest selected fishing station, where the lines and nets will be set whilst the steamer uses her trawl. In the morning the catch will be counted. The fishing boat will then sail to the nearest port, while the steamer will proceed to the next port and repeat the same operation. These fishings are to be made four times a year.

1502. I see that you have described the three methods as to examination of the fish at the port of landing, but might not the same result be obtained partly by information from statistics furnished by commercial trawlers—I mean in that case the examination at the port of landing would be one way of getting that information from the commercial trawlers, but it would not be the only possible way?—I do not think you would get the same amount of information unless you were able to examine the fish. I think with your permission I should propose to refer to that towards the end of my paper, and to take each of those points in turn.

1503. At present you are still on the first method of special steamers. Do you see some objection to that being used as the sole method?—Yes; it seems to me the principal objection to this as the sole method, so far as I am at present aware, is that it cannot be relied

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upon to afford trustworthy information on what seems to be one of the primary objects of these investigations, namely, the variation in the abundance of fish from time to time on the same or different grounds. Unless the quantity of fish is unlimited, there must be a point at which the quantity taken by each boat or each net would be affected by the number of boats or nets fishing. If, therefore, the total catch is maintained a decrease in the catch per boat might be due simply to the catch of fish being distributed among a larger number of boats or nets, and not to any depletion of the fishing grounds. This objection would apply equally to conclusions as to the increase or falling off of particular fisheries based on returns made by selected boats.

1504. And that objection, of course, would apply equally to a special steamer as it would to any other boat?—Yes.

1505. That is to say that the results obtained by a special steamer would not afford anything like a conclusive proof as to the density of the fish population?—No.

1506. Because, as you pointed out, the other boats might be fishing. Supposing there was a decrease there might be such an increased number of other boats that they would account for it?—Quite so.

1507. You refer to that Thirty-ninth Annual Report of the Inspector of Fisheries?—Yes, that is to show that this is not a merely theoretical objection, but one of considerable practical importance. I had this question particularly brought under my notice before the Salmon Commission. We had before us a Report from the Norwegian Salmon Commission, in which they had estimated the rise and fall of the fisheries by the take per net. I then had occasion to point out that such a method of estimating the rise and fall of the fisheries appeared to me wholly fallacious. It will be seen from the Thirty-ninth Annual Report of the Salmon and Freshwater Fisheries of England and Wales, page 15, where an account is given of the Norwegian fisheries, that the average take per net in the first period of seven years is 215 kilos; whereas it is only 154 kilos in the last period of seven years; consequently, if the average take per net is a fair standard of comparison of the rise and fall of fisheries, a great falling off is shown. But if this was the case, and if the increased take in the sea nets—the take of fish per net to which I am referring is the take of fish per sea net.

1508. Is that salmon?—Yes. I say if this were the case, and if the increased take in the sea were due solely to an increase in the powers of capture, a smaller proportion of the available stock would be captured in the rivers, where it is shown that the powers of capture have decreased. The figures show, however, that there has been an increase both in the river as well as in the sea in the last as compared with the first period.

1509. I see. Do you see any other objection to trusting entirely to special steamers?—It appears to me, apart from this objection, the question of whether, except at a very considerable cost, work can be done by means of special boats on a sufficiently large scale to be of any practical value to the fisheries requires serious consideration.

1510. You intend that remark no doubt to apply to the employment of special boats even for hydrographic purposes?—Certainly, although it is a matter on which I have at present quite an open mind. I feel that hydrographical investigations cannot be carried out without special steamers, but whether work of practical value can be done by such a number as are likely to be available has still to be proved. If the evidence which is put before us substantiates the assumption which appears to underlie the theory on which the chart appended to Dr. Hjort's report is based, then for this purpose they should be of great value.

1511. That is to say if they enable one to ascertain the salinity and temperature of the sea in a large area?—Yes, if the physical conditions are more or less uniform over the ocean.

1512. Then you have some further observations, I think, to make about that with reference to the evidence given before the Select Committee in the House of Commons in 1893?—Yes, it appears from the evidence given before the Select Committee of the House of Commons in 1893, and before the Departmental Committee on Fishery Statistics that the trawlable area of the North Sea is about 100,000 square miles. *This* map is my authority. It was put forward by Mr Alward in answer to Questions 229 and 230 given before the Select Committee of the House of Commons in 1893, and in answer to Question 118, given by him before the Statistical Committee in this year. It shows that the trawl fishing in the year 1893 was carried on between latitudes 51° and 59° north, from the eastern shore to the western shore. Within this area there are 146,000 square miles of sea. The area suitable for deep-sea and in-shore trawling is about 94,000 square miles. The area covered by oyster beds is 14,000 square miles, and the remaining 38,000 square miles consists of rough bottoms, excessive depths, and shallow patches unsuitable for trawling. Since 1893, when this map was made, the introduction of the otter trawl has enabled greater depths to be visited than at that time, and the trawlers are going rather further north in the North Sea. Before the Statistical Committee, Mr. Alward estimated that the trawlable area is now 137,000 square miles.

1513. You think that you are within the mark when you say it is over 100,000 square miles?—I think so.

1514. What inference do you draw from the great extent of that area?—I find by calculation that a steam trawler having a spread of net 75 feet broad, and working for 15 hours a day, during 280 working days, and trawling over each station once a month, would only be able to cover an area equivalent to about 17 square miles. It appears to me therefore obvious that any systematic attempt to survey such a large area as the North Sea by special steamers, must be done by means of small samples taken at wide distances apart, otherwise it must take a great number of years.

1515. And with regard to the samples, what have you to say?—The samples to be trustworthy must be representative, otherwise any conclusions drawn from them will be erroneous.

1516. Is there no qualification of the observation you make with regard to the North Sea; the depth, for example; are there not limited areas such as banks where particular kinds of fish might be supposed to be found, and they could be explored, could they not?—It depends, of course upon the size of the banks. A few selected steamers should do a limited amount of work.

1517. For example if there was reason to suppose that flat-fish were to be found on particular banks, to take a very small bank such as Smith's Bank on the Moray Firth, and, I presume, also banks on the German Ocean I do not know whether the Dogger Bank has flat fish on it, but such a limited area as that might possibly be satisfactorily explored, might it not?—On a small bank, where it is possible to take a sufficient number of observations to test the value of the samples obtained, I think that special boats would be of value. Provided of course that the disturbing factor created by other trawlers working over the same ground was eliminated.

1518. Then what further remarks have you to make about special steamers?—It seems to me that if the work is to be done by special steamers, that is to say, the work proposed by the Conference—this large survey—it will be necessary before any definite scheme can be laid down to determine: (1) How far hauls of the trawl taken at one place afford a fair sample of the fish at that place in the same and different seasons; and (2) how far samples taken (a) at neighbouring places, or (b) at places some distance apart where the physical conditions are approximately the same, give a constancy of result.

1519. If these things are to be a preliminary to this at all, how are you to arrive at the information which was wanted here?—It seems to me that if the work is done solely by a few special steamers it can be only arrived at by making a number of hauls of the trawl within very short distances of one another on particular banks, and by that means ascertaining how far the conditions of the bank are uniform, and whether one line can be laid down on that bank, which may be taken as fairly representative of the whole.

1520. Then, I think, with the view of throwing light on this question you have made analyses of experiments?—Yes, of the trawling experiments made by the "Garland" in Scotland.

1521. Would you explain them, please?—The experiments dealt with are those made in the Firth of Forth in the period of 1889 to 1895. Before going on to that, might I just say that this proposal to test samples is not a new one? In all schemes of research in which I have worked by samples or have fixed standards of comparison, I have always made it my first duty to test such samples or standards. As an example, I would refer to the 14th annual report of the Scottish Fishery Board, Part II., p. 9, and the special report on the

"Life History of Salmon," pages 7 and 9 to 11. I give this reference to show that this proposal of mine is simply a continuation of the same method of work as I have always worked on since I have taken up the investigation of fishery problems. The experiments dealt with are those made in the Firth of Forth from 1889 to 1895. They were selected because they afforded the most extended series of observations over one area. I may explain that these experiments in the Firth of Forth were apparently made periodically from 1886 to 1895, but in the first two years the size of the fish was not distinguished except by such general terms as "medium," "large," "very large," "small," and "very small," and in 1888 the observations were chiefly confined to the later months of the year. It was not until 1889 that each station was trawled over, as far as possible at intervals of one month. For these reasons, therefore, I have limited my analyses to the seven years already mentioned. During this period hauls were made as far as possible once a month. In all 616 hauls were made, and 22,149 plaice, 20,023 common dabs, 34,107 haddock, 15,222 whiting, besides other fish, were taken, the four kinds selected being the flat fish and round fish respectively, which were taken in the greatest numbers. Now slight irregularities arise as to the day and month on which these trawlings were made, the method of tabulating the fish, and other points of a somewhat similar kind. I do not wish to weary the Committee by going into these matters in too great detail, but it appears that it is very important that the Committee should have full information as to the premises on which the evidence which follows is founded. I propose therefore to put in a table showing the actual days on which the trawlings were made, and tables showing the mean day on which the stations were trawled over and the interval between the mean days. I might remark that the table showing the mean day upon which the stations were trawled over shows that the highest difference in any one month between the mean day on which different stations were trawled over did not exceed seven days—that is to say, in December, the 16th was the earliest mean day on which any station was trawled over, and the 23rd the latest. I now put in these tables*—Tables I. (a), (b), and (c). But it will be seen from Table I. (a) that there are certain months in which no observations were made at all. Out of a possible 84 months, observations were taken in 72 months. I therefore thought it would be desirable to ascertain how far the general result would be affected by the interpolation of a figure for those months in which no trawlings were made.

1522. What do you mean by interpolation?—That, for the purpose of this table, I have assumed a figure for any month in which no trawlings were made. The assumed figure is based upon the value of the month in those years in which observations were taken, and upon the value of the year in which the month occurs, when no observations were taken. Thus, if it was required to interpolate for September, 1889, the proportion would be, that as the mean for 1889 is to the mean for 1889-95, so is the mean of September, 1889-95, to x.

1523. And x is the figure you get?—Yes.

1524. When you speak of the mean of 1895, do you mean the 11 months of 1895, because you have not got September?—But I have September in other years.

1525. But you said the mean of 1895; read that again at the beginning?—As the mean for 1889; 1889 was the year in which I was assuming that no observations were taken in September.

1526. What do you mean by the mean of 1889, when you only have 11 months?—I calculate the value of the year on the mean of those months in which observations were taken, and the value of the month on the mean of the same month in other years.

1527. I suppose some months are normally different from other months—they are more abundant?—Yes.

1528. I do not know whether you get it there or not, but would not the most instructive datum there be the mean of the six other Septembers; would not that bring you most nearly to what the seventh September is likely to be—do you follow me?—I do take that into consideration. I take two points into consideration. I take the value of the month and the value of the year for which the month is omitted.

1529. You get both?—Yes.

1530. It might, for example, be a very good year?—Yes.

1531. And that would raise a probability that that September would be better than another September?—Yes.

1532. But to be accurate, and I think you agree with me, you also need to take into account the mean of the six other Septembers?—Yes, and that is what I did. I found, however, that the effect of interpolation was so slight when divided over the mean of the whole period as to be almost inappreciable. In most cases it was only in the decimal points that it made any difference. I came to the conclusion, therefore, that interpolation was unnecessary, and that the actual figures given in the Scottish Fishery Board's Report gave a sufficiently accurate result. I put in a table to show this—Table I. (d). There was one other point of difficulty which had to be overcome, and that was that in the earlier years the sizes in which the fish grouped did not always coincide with those for the later years. The fish might occasionally be given as between 6 and 9 inches, or between 6 and 8 inches, instead of the number between each inch as in the later years. Therefore, where this has occurred the numbers have been apportioned, so that in groups of 6 and under 8 inches, half would be placed to the lower and half to the higher figure; in those of 6 and under 9, one-third at each figure. The last point calling for consideration is the variation in the length of hauls at different stations. To enable the results of one station to be compared with those of another, a calculation has been made of the number of fish taken per mile trawled over, and the figures given in the tables refer in every case to this common unit.

1533. And what results do you get?—The first point brought out is that an observation taken in one month does not represent the conditions at the same place and in the same year in another month; the second, that observations taken in the same month and at the same place in different years do not give similar results. Chart II. illustrates, as regards plaice, the fluctuations in separate hauls on the same ground in the same month in different years, and the fluctuations in hauls made on the same ground in different months in the same years.

1534. (*Mr. Green.*) Are you taking one class of fish, flat fish, or mixing them all up?—I am at present only taking plaice. (I have not illustrated the fluctuations in other descriptions of fish by means of charts, they are shown in Table III.)* The thin lines represent the maximum and minimum take in any month, the thick lines the average monthly take over the whole period. Since only one trawl was made in each month, the thin lines show the difference between a haul made on the same ground in the same month in different years, and the thick lines the difference between hauls made on the same ground in different months of the same year. It will be seen that the take varies considerably on the same ground in the same month in different years, and in different months in the same year.

1535. (*Mr. Spring-Rice.*) This is the average upon the days per mile?—The average take per mile trawled over.

1536. Which station is that (*pointing*)?—That is Station I. This is Station II. For the present I am only putting forward these charts to illustrate the difference in the take in different months and in the same months in different years; as I shall be using them later on for another purpose I will not now enter into them at any length. I should mention, however, that in hauls on the same ground in the same month in different years the following variations are shown:—Plaice, 8 to 73; common dabs, 0 to 112; haddocks, 0 to 296; whiting, 0 to 130. The monthly variations in the same year on the same ground are as follows:—Plaice, from 8 to 43; common dabs, 1 to 59; haddock, 2 to 87; whiting, 1 to 24. In the absence of observations taken at shorter intervals than once a month it at once became obvious that, if anything was to be learnt as to how far hauls made at one place afforded a fair sample of the fish at that place, the results must be treated collectively by a statistical method. I have therefore applied two tests, the first showing the continuity of result underlying the average number of fish caught; the second the continuity of result in the average size of the fish. Reference to Chart II. shows that, although there is great irregularity in separate hauls, the results of each station when grouped according to months already begin to show some continuity of result in the relation between the monthly maxima and minima and the monthly averages. There are some exceptions, but, as

* *See* Appendix IV.

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a rule, where the average is higher the maxima and minima never fluctuate at a higher or lower level.

1537. (*Mr. Crawford.*) We observe that—shall I go further into that subject?

1538. (*Mr. Pelham.*) What does the other sheet show? You said the other sheets?—Each sheet or chart represents a different station. The average of seven hauls made in the same month shows a great difference from month to month.

1539. (*Mr. Crawford.*) Speaking generally, are the best months the same at every station?—No, but I shall go into that question later on. The continuity of result underlying the average number of fish caught is brought out in a marked manner with regard to plaice and dabs, when the average number caught during the whole period are grouped according to stations. This is illustrated in Chart III., showing the average quantity taken at each station, and the maximum and minimum quantity taken in any one year. The thick lines show the average number of fish taken per mile trawled over during the whole period of 1889-1895, and the thin lines the maximum and minimum take in each year. It will be seen that in the case of plaice and dabs there is a marked difference in the average quantity taken at different stations, and that with almost every rise in the average there is a rise in the maximum and minimum. For instance, for plaice taken at Station I. the average is not quite seven, and the minimum and maximum are lower than at Stations II., IV., and VI., where the averages are higher. The only exception to this rule, which is a very slight one, is between Station IV. and Station VI., Station VI. having a slightly higher average than Station IV., although the maximum is not quite so high as Station IV. But the very marked difference between the average quantity of the fish caught at each station, coupled with the continuity of result between the yearly maxima and minima and the average over the whole period, seems to me to afford very strong ground for believing that these observations afford a fair indication of the relative quantity of fish at each station. In the case of haddock and whiting no such continuity of result is apparent. There is a marked difference in the average quantity caught at each station, but there is not the continuity of result between the maximum and minimum takes.

1540. (*Mr. Pelham.*) Just a moment. You say that the maximum and the minimum of each month very very much as the average does—they show continuity? Yes.

1541. You do not show there, of course, the year between the maximum and the minimum?—No, I do not. That, of course, can be seen from the detailed tables, but it did not seem to me for this illustration that this was necessary. There is, of course, an overlap between the maximum year at one station and the minimum at another. The result would have been more certain if there was no overlapping at all; that is to say if the maximum year at one station did not reach the minimum at another. There is over-lapping to that extent, but it appeared to me that the difference was quite sufficiently marked to substantiate the conclusion which I venture to put forward.

1542. (*Mr. Crawford.*) Did that happen—that the maximum of one year did not reach the minimum of another?—We are now dealing with the variation between station and station. In some cases the maximum year at one Station did not reach the minimum year at another.

1543. With regard to the second test?—With regard to the second test, which has been only applied to plaice, there is great irregularity in the number of each size taken in separate hauls. These irregularities become considerably smoothed out when the hauls made at each station are grouped according to years or months, and show a marked regularity at Stations I. to VII., when taken over the whole period. At Stations VIII. and IX. the numbers are so few that they must be disregarded. The relative number of plaice of each size is shown on Chart IV. It will be seen that the curves rise and fall with considerable regularity. At Stations I., II., and VI. the regularity of the rise and fall from the size at which the smallest numbers are taken to the size at which the largest number is taken is the most marked. At Station IV. a dip occurs between the fish of ten inches and the fish of twelve inches in length, but as a somewhat similar dip occurs at Stations III., V., and VII., it would seem to be due to some definite reason, and not to insufficiency of observations. This regularity from the size at which the smallest number occur to that at which they occur in the greatest number seems to me to show that in the fish caught we have a fair sample of the relative distribution of place, and thus to confirm, as regards Stations I. to VII. inclusive, the conclusion arrived at from a study of Chart III. (a).

1544. (*Mr. Pelham.*) Will you explain a little about the number there and the size?—The numbers are the vertical measurements and the sizes are the horizontal measurements.

1545. Then the same stations have the biggest size and the biggest numbers?—Yes.

1546. (*Mr. Crawford.*) Are Stations VIII. and IX., where the numbers were insufficient—how are they geographically situated?—They are further out and also in deeper water than most of the other stations.

1547. (*Mr. Spring-Rice.*) But they are the two well outside?—Yes.

1548. (*Mr. Crawford.*) What inference do you draw from that?—I drew the inference that the experiments made by the "Garland" do afford a fair sample of the fish present at each station; that is to say, the answer to my first proposition seems to be that hauls of the trawl continued for a number of years at one place do afford a fair sample of the fish at that place. This being the case we can now proceed to consider how far samples taken at neighbouring places give a constancy of result.

1549. (*Mr. Pelham.*) That first proposition that you laid down—those conclusions mean, of course, that the trawl in each year is taken over exactly the same site?—Yes, over the same site. Of course, as far as it was humanly possible to do it. I assume that the Fishery Board's observations were properly carried out, and that every precaution was taken to trawl as far as possible over the same site, and as there were definite marks on the shore from which observations could be taken, there ought not to be much difficulty in coming tolerably near to the same place each time.

1550. (*Mr. Green.*) And also the same state of tide—they observed the same time of the tide?—I am not sure as to that. I have not gone into the question of tides. In the Fishery Board's Reports, in dealing with this question, they do give the state of the tide, and a good deal of other valuable information which I cannot help thinking would be of great interest to analyse in this same way; but I have not done so. I thought that an analysis of the physical conditions, other than the nature of the bottom and the depth of water, would not be of much value for my present purpose. Because in considering the detailed method by which investigations are to be carried out in the North Sea, the only information with regard to the physical conditions that we can rely upon at present is that given in the Admiralty charts with regard to the nature of the bottom and the depths. Therefore, I have not taken the other physical conditions into consideration.

1551. Do they discriminate between observations when they were towing with or against the tide? Two hauls taken on the same day, and on the same ground, one with and the other against the tide, would give entirely different results with the same conditions otherwise?—I have not gone into that question.

1552. (*Mr. Crawford.*) Would you kindly go on with your evidence?—The trawling experiments in the Firth of Forth were made along nine selected lines. The position of these lines will be seen on the accompanying chart of the Firth of Forth, together with the depth of water, the nature of the bottom and the average number of fish taken along each. It will be observed that four of these lines (I. to IV.) lie to the westward of a line drawn from Gullane to Largo, of which two are on the northern and two on the southern side of the deep water channel. Three of the stations are further eastward, of which one is on the northern side of the Firth and one on the southern side, and one in the deep water channel. The relative depth at each station is shown graphically on a section attached to the chart.

1553. (*Mr Spring-Rice.*) Which are IV. and VI. on that chart?—*Here* is IV., *there* is VI. In addition to the 7 stations I have already referred to, there are two (VIII. and IX.) immediately outside the Firth to the southward and south-eastward respectively of May Island. I have indicated on the chart by means of vertical and horizontal black and red lines respectively the quantity of fish taken per mile trawled over at each station. The black vertical lines represent plaice, the black horizontal lines represent common dabs, the red vertical lines represent haddock, and the red horizontal lines represent whiting.

1554. On this chart?—Yes. Now, it will be observed that even between neighbouring stations there is a great irregularity in the number of each kind of fish taken. In illustration of this I may point to the difference in the relative number of each kind on Stations III. and IV. Those stations are situated on a gently sloping bank, as will be seen from this section, on the southern side of the Firth. At no place are they more than 3½ miles apart, and they approach within less than a mile of each other towards their eastern end. It will be seen that plaice are five times more numerous at Station IV. than at Station III. Whiting and haddock are five and six times more numerous at Station III. than they are at Station IV., and about 20 per cent. more dabs are taken at Station III. than are taken at Station IV. This seems the more striking because in the fifth annual report of the Scottish Fishery Board, after trawling operations had been carried on for one year, these stations were described as resembling one another very closely, both as regards fish and the surface and bottom fauna. I do not know whether you would like me to go into a more detailed comparison of the different stations. I can take those stations which seemed to me to have most similarity as to position, and show how they compare. I am at present dealing with the position only, and not with that of the question of the nature of the bottom or of the depth.

1555. The position in relation to the shore line?—In relation to one another.

1556. (*Mr. Green.*) And these results show that the plaice there are very numerous?—Yes.

1557. (*Mr. Crawford.*) I suppose we can go from station to station by that chart?—Yes, I can just run through it very briefly, if you would like me to do so.

1558. At Stations I. and II. you will see that the average number of plaice taken per mile trawled over are 6 and 12 respectively; therefore there are double the quantity of plaice taken at II. to what there are at I.; 6 common dabs are taken at I., 17 at II., or three times more at II. than at I. Double the number of haddock are taken at II. than at I., and only half the quantity of whiting.

1559. (*Mr. Pelham.*) What are the relative depths of these two stations?—Will you allow me to give that afterwards?

1560. Before you leave that station will you give us a general indication of the depth of those Stations I. and II.?—The average depth of Station I. is 11¾ fathoms, and of Station II. 13 fathoms. Stations III. and IV. are both under 10 fathoms, viz., 8½ and 5½ fathoms respectively.

The quantity of plaice taken at IV. is five times greater than the quantity of plaice taken at III. The quantity of dabs taken at IV. is 17 per cent. less than the quantity of dabs taken at III. The quantity of haddock taken at IV. is five times less than the quantity taken at III. The quantity of whiting taken at IV. is six times less than the quantity of whiting taken at III.

Stations III. and VII. would appear to be two hauls along the same bank, at an interval of 4 miles apart. They compare as follows:—The quantity of plaice taken at each is nearly the same; common dabs are three times more numerous at VII. than at III.; haddock are five times more numerous at VII. than at III.; whiting are 12 per cent. less.

Stations I. and III. are ¾ of a mile apart at their nearest point, 2½ miles at their furthest. The deep water channel apparently does not separate them until about half the distance of the haul along one and about one-third of the distance along the other has been covered. They compare as follows:—Plaice at I. are twice as numerous as at III.; common dabs 20 per cent. less at III. than at I.; haddocks correspond very nearly, there being only 1 per cent. difference between them; and whiting also correspond, there being less than 1 per cent. difference between them.

Stations V., VIII., and IX. are all situated in the deep water round May Island. It will be seen that between four and five times more plaice are taken at V. than at VIII.; 20 per cent. more common dabs at VIII. than at V.; double the number of haddock at V. to what they are at VIII.; that whiting are 25 per cent. more numerous at VIII. than at V. Stations VIII. and IX. correspond in the following proportion: Plaice twice as numerous at VIII. to what they are at IX.; common dabs 30 per cent. more numerous at VIII. than at IX.; haddock 22 per cent. less at IX. than VIII.; and whiting 58 per cent. more numerous at VIII. than at IX.

A comparison between V. and VI., which are neighbouring stations as to position, shows a very great difference. There are seven times more plaice at VI. than at V., there are four times the number of common dabs at VI. than there are at V., and five times more haddock at V. than at VI., and 28 per cent. more whiting at V. than VI. That completes the comparison of those stations having the most similarity as to position.

1561. (*Mr. Crawford.*) I presume that you have said all that you want to say on this chart at present?—Yes.

1562. What is the next point?—The next point is how far annual fluctuations correspond at different stations—that is to say, how far observations taken at one station can be relied on to show the increase or decrease from year to year in the number of fish at other stations. And this I propose to illustrate by means of Chart V. The year in which the fluctuations occur are shown by the horizontal measurements; the average quantity of fish per mile trawled over by the vertical measurements. A general glance at that chart will show that, as regards plaice and dabs (slightly less as regards dabs than plaice), a good year at one station may be a bad year at another. I draw attention in my statement to the example which this chart affords of the danger of drawing conclusions on this point from a limited number of observations.

1563. It occurs to me, and I think that the Committee are of the same opinion, that if you give us one example and refer us to the table, and compare it to the stations in that respect, that will be sufficient. You can say anything that you think necessary to elucidate the point?—I will first take Stations III. and IV. on Chart V. (a) as an example that a good year at one station may be a bad year at another. III. is the black dash and dotted line; IV. is the red line—*here* is III., *there* is IV. It will be seen that in 3 out of 7 years a rise at one station is a fall at the other. (*Witness here explained the rise and fall on Chart V. (a).*)

1564. That is with reference to plaice alone?—Yes. I could go on to dabs if you like.

1565. I think not. We see your method; we follow it on the chart?—Is that illustration sufficient for that point?

1566. Yes?—I will next call attention to the example which this chart affords of the danger of drawing conclusions on this point from a limited number of observations. It will be seen that, although Stations IV. and VI. are situated on different sides of the Firth, there are some points of similarity between them. Both, it will be seen, are inshore stations; both are the only stations where the bottom is chiefly composed of sand; they are the two most productive stations for plaice; they have yielded over the whole period almost the same average quantity; and during the first three years the rise and fall is almost exactly parallel. In these circumstances, if the observations at both stations had not been continued, it might perhaps have been not altogether unreasonable to consider that there were good grounds for believing that observations made at one represented, as regards the number of plaice, the state of affairs at the other. The experience of the last four years, however, shows that such a conclusion would have been erroneous, as in these years there is a marked contrast in the annual fluctuations, a rise at one station being always accompanied by a fall at the other. (*Witness here explained the rise and fall on the chart.*) Before leaving Chart V. I should point out that there is rather a greater constancy of result in the annual quantity of haddock and whiting at different stations. The constancy is not absolute, as will be seen from the chart, but as regards haddock at most stations 1893-1895 are good years, whereas the four previous years are bad. In whiting it will be seen that 1890 was a good year at nearly all the stations, whereas the other years are very much worse, although they fluctuate to some extent independently of one another.

1566.* The next point that arises seems to prove that what is a good month at one place is not always a good month at another?—Yes. It will be seen from Chart VI. (a) that the months in which plaice are taken in the greatest abundance vary very considerably at different stations.

1567. (*Mr. Pelham.*) What do the different colours represent?—The different colours represent the different stations. The horizontal measurements represent the

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months and the vertical measurements the quantity of fish taken. As an example I may point to Stations III. and IV., where in 6 cases a rise at one is a fall at the other.

1568. Which is that line?—That is the black dotted and dash line.

1569. (*Mr. Spring-Rice.*) Which is the line with an apex close to your left hand?—That is Station VI.

1570. And what is the one with two points?—That is Station IV.

1571. (*Professor Herdman.*) What magnitudes are you dealing with; is it units or hundreds?—Units.

1572. I mean with reference to such a fall as that you showed just now?—It is a fall from 29 to 12 fish per mile trawled over.

1573. (*Mr. Crawford.*) That is plaice?—Yes. Then as regards dabs it will be seen that there is a greater similarity than in the case of plaice, but the difference is still sufficiently marked to prevent observations taken at one station being relied upon to represent the monthly fluctuations at neighbouring stations. For instance, a comparison of Stations I. and II. shows that in four cases a rise at one is a fall at the other. The monthly fluctuations in haddock and whiting present greater similarity. The exception is apparently at Station IV., where an insignificant quantity of haddock is taken. With regard to whiting, the last six months of the year are generally more productive than the first.

1574. What is the next point you wish to deal with?—The next point is, how far the size of fish is constant at different stations. Now, you will see from Chart IV. that, except at Stations V. and VI., the size at which the greatest quantity of plaice is taken is fairly constant. The vertical measurements show the number of fish taken, and the horizontal measurements show the size of the fish taken. At Stations I. to IV. and VII. the apex is reached at 12 inches in length; at Station VI. at 14 inches; and at Station V. at 13 inches. Stations VIII. and IX. may be left out of consideration, because the numbers are so small. In considering this question the number taken at each station must not be lost sight of. From this point of view the example which Station VI. gives of an apparently small but very productive area, where fish of a large size are taken, situated within a much larger but less productive area where the fish are smaller, throws doubt on the value of conclusions as to the size of fish within a given area based on observations taken at a limited number of stations. For instance, of the plaice of over 12 inches in length taken at all stations, more than 50 per cent. were taken at Station VI. If, therefore, fewer observation stations had been selected, and Station VI. had been omitted, a different conclusion would be arrived at on such a question as that of the size limit necessary to exclude trawlers from this area.

1575. (*Mr. Pelham.*) Where is Station VI. on that chart?—*There* (*pointing*).

The last point to consider is how far samples taken at stations where the depth and nature of the bottom are approximately the same give a constancy of result. The relative abundance of fish, according to depth and nature of bottom, is illustrated by Chart VII. In this chart the horizontal measurements represent the number of fish taken, and the vertical measurements represent the depth. It will be observed that with regard to plaice that at stations having a less depth than 10 fathoms the number varies from 4 to 20—I will omit the decimal points. This variation occurs at what may be regarded as neighbouring trawls on the same bank; and, it may further be added that, according to Admiralty Chart 234, there is nothing to indicate that there is any difference in the nature of the bottom, it being from the Fishery Board for Scotland's reports that we learn that the bottom at one is sand and shells and at the other mostly mud. Between 10 and 20 fathoms the number varies from 4 to 21. It will be seen, as a matter of fact, that this variation takes place between trawls made at stations having an average depth of from 11¾ to 14 fathoms. Between 20 and 30 fathoms the take varies from 0·29 to 3·02. The maximum take in the last group, therefore, is scarcely equal to the minimum take in the first and second groups; but there is no constancy in the fluctuations within each group. With regard to the nature of the bottom, the take is greatest at Stations IV. and VI., where the bottom is described as "sand and gravel" and "sand and shells." On the other hand, fewer fish are taken at stations where the bottom is described as "sand, mud, and stones," and "sand and mud," than at stations, of approximately the same depth, where it is described as "chiefly mud" or "mud." The nearest approach to any constancy would appear to be in the case of dabs, where the greatest number are found between 10 and 20 fathoms, fewer under 10 fathoms, and least over 20 fathoms. But the fluctuations in the numbers taken between 10 and 20 fathoms are too marked and the difference between each group too slight to allow of any importance being attached to the result. The answer, therefore, to my second proposition appears to be, so far as these observations are concerned, that samples taken at one place cannot be relied upon to give any constancy of result at neighbouring places or at places where the depth or nature of the bottom are approximately the same, either as regards the average number, the number of each size, or the annual or monthly fluctuations in the number of fish taken. It would have been more satisfactory if it had been possible to compare trawlings made at the outer stations in the Firth of Forth with those made in St. Andrews Bay and the Moray Firth. Unfortunately the number of observations taken in those localities, at approximately the same time, are too few to allow of this being done. But unless it can be shown that the conditions are more uniform over the North Sea generally than they are in this particular area, it would seem that any conclusions with regard to the distribution of fish based on samples taken at some distance apart are more likely to be erroneous than true, and so far as these observations go they point to the necessity of conducting the work on a broader basis than is practicable by means of special survey steamers. That finishes what I have to say on the subject of the first method of investigation.

1576. That is by special boats?—That is by special boats.

1577. Then as to the second head?—It seems to me obvious from what has already been said that observations to be comparable must be taken at the same place and at the same season, and that a sufficient number of observations must be made by different boats to make it probable that some boats may have been over each ground at least once a quarter. This would entail such a large staff of experts that it would seem to me to be impracticable on the ground of cost. Isolated observations made at different seasons would be valueless. It would seem, therefore, that the chief use of such experts would be to instruct skippers of trawlers as to filling up a few simple facts on forms supplied for the purpose, and to ascertain which skippers could be relied upon.

1578. I suppose if that were attempted on anything like a large scale it would be difficult to get accommodation for experts, would it not?—It might, although we have, of course, the instance of Mr. Holt, who found accommodation on the Grimsby trawlers, but I am given to understand that it is exceedingly uncomfortable.

1579. They probably have not room to start with for more than their complement of men, and then there would be no convenience for scientific work of any kind?—No, there would not. Of course what they would be able to do would be to ascertain where the fish were caught and the quantity of fish caught, and then if they did that, when the fish was brought to land the material would be available for scientific purposes.

1580. But might it not be possible to get that information otherwise, by interesting the captains?—That is what I deal with under my third head. The third method is by the examination of fish at the port of landing. This method seems to afford as regards food fish the best opportunity of collecting a large amount of material at a moderate cost. In 1900 there were nearly 1,200 British steam trawlers fishing from the North Sea ports. This number is sufficient to cover the whole trawlable area of the North Sea nearly twice over in the course of the year, on the assumption that each boat has a spread of net 75 feet broad, that it works for 15 hours a day during 280 days, and that the trawlable area of the North Sea is 100,000 square miles. I simply state that, of course, by way of illustration, it being the same assumption that I made in the case of the single boat. It can hardly be doubted, therefore, that material for investigation from all parts of the sea at every season of the year must be landed annually if it could only be made available. To be available it would be necessary to know where and when the

fish were caught. This information is already available to a considerable extent as regards the sea-borne fish landed at Billingsgate. These fish are brought to London by steam carriers from three Hull fleets which fish in the North Sea. From the inquiries which I have made of the owners it appears that the vessels forming these fleets carry no ice, but (weather permitting) deliver their fish daily to steam carriers which bring the fish direct to London. The skipper of the carrier fills in on a form particulars as to the position of the fleet at the time of boarding, the number of vessels boarded, and the catch of each vessel. I propose to hand in for your information copies of these returns. (*Copies were handed in.*)

1581. (*Mr. Spring-Rice.*) That covers the sea borne trawl fish at Billingsgate?—Yes.

1582. And their value is over half-a-million a year?—I should hardly like to commit myself to the actual amount without referring to figures.

1583. The value is very large?—Yes, it is very large. The owners further state that the fish are caught within a comparatively small radius of where the carrier receives them. These limits might possibly be more exactly defined in the case of particular boats. The North Sea Mission Steamer usually accompanies one of those fleets, and I have had some conversation with the Secretary of that Mission, and he seemed to fall in very readily with the desire to help these investigations in any way in his power.

1584. (*Mr. Pelham.*) He would be able to give evidence as to the locality I suppose more than anything?—He would be able to collect information with regard to the locality, I should be almost more inclined to say. The evidence with regard to the locality, if he had not had it tabulated methodically, might not perhaps be altogether reliable.

1585. (*Mr. Crawford.*) You think that that system might probably be capable of extension?—I think it seems to afford at any rate a direction in which we should inquire whether something could not be done. Reliable skippers sailing from other ports might also be asked to fill up a simple form of return, showing the number of hauls on each ground visited, and the quantity and description of fish caught, and further to set aside sample boxes of the fish caught on each ground. These forms, together with the sample boxes of fish taken at each haul, should be handed over to a trained expert at the port of landing, who would measure the fish contained in them, and record the number and size of each description on a form having a reference number showing the particular catch of which it was a sample. The ovaries of a few fish should be weighed, and the viscera or other material which might be required by the biologists should be sent to the laboratory for examination. The remainder of the fish should immediately be sold, so as to keep down expenses. The kind of man whom I employed to do similar work when in Scotland was a laboratory assistant who received rather less than £1 a week. It appears to me, from the experience that I had in Scotland in conducting similar investigations with regard to salmon, that investigations on these lines would afford information on the following points, namely, (1) the size and description of fish frequenting different grounds at the same and different seasons; (2) the condition of the ovaries at different seasons, and the grounds, if any, where fish chiefly congregate when approaching sexual ripeness; (3) the food of fish; (4) the limits both as regards latitude and depth at which different kinds of fish are found; (5) the existence of special local races of various species, as in the case of herring. We also did a great deal in that direction in the case of salmon, but I have referred more particularly to herring, as I think they are the better known investigations, and they also bear upon sea fisheries, whereas I shall perhaps be considering salmon with you at a later period. In fact, they would comprise the investigation of these points of immediate importance on which early information is urgently needed. It appears to me that the immediate English interest in deep sea research is to obtain information with a view to legislation for the protection of small flat fish. The English interest in this question is greatly in excess of that of Scotland and all the other countries bordering on the North Sea combined. It will be seen from the last annual report of the inspectors (England and Wales) that there were 1,104 English steam trawlers on the register. Of these 1,027 sail from North Sea ports, whereas the combined fleets of Scotland, Belgium, Denmark, France, Germany, and the Netherlands sailing from the North Sea ports is about one-third of that number. Sweden, Norway, and Russia have apparently no trawling interests in the North Sea. I ought to qualify that last remark by saying that I understand there are a certain number of trawlers sailing from Grimsby at the present time under the Norwegian flag. Statistics from these selected boats would not afford information to show whether there is any falling off or not in the abundance of fish, nor material for investigation with regard to fish not caught by the ordinary methods of fishing, fish-food, or fish eggs. The former, for the reasons already given, must be obtained from all boats; the latter require the use of particular kinds of nets. For the former, therefore, we must depend on the general statistics, which should be collected in the most complete possible manner; for the latter, on such material as can be collected by special steamers.

1586. (*Mr. Pelham.*) As regards your analysis of the information which has been obtained by the trawling in the Firth of Forth, I understand you to say that it appears that the trawls on the same spot for some years do give some constancy of result?—Yes, that is what the figures seem to show.

1587. But judging from those investigations, you would say that the returns from one station in the Firth of Forth do not give any reliable idea of what the returns should be in an adjoining station?—Yes, that, I think, is the conclusion to be drawn from the figures.

1588. (*Mr. Green.*) Following on that, you think there is a considerable difference between the conditions of fishing grounds in a narrow place like the Firth of Forth to those in the North Sea, and that these differences which occur may be due to the fact that certain classes of fish have their particular haunts in a narrow estuary like that?—I think for me to express any opinion upon that point would be simply a matter of speculation, and I cannot do more than put before you those investigations which I have gone into.

1589. Then the sample boxes of fish from a trawler, do you think it would be possible for the captain of a trawler to select a sample which would be a fair sample of the lot of fish taken by that trawler on a certain voyage?—I understand that the present method of counting fish on board special boats, when a large quantity of fish is taken, is not to count each individual fish, but to count a certain measure of the fish, and then to put all the other fish through this measure, and according to the quantity of each description of fish which you have got in your sample, you estimate the total quantity of each description taken. It seems to me that if the captain could be induced to put aside a sample box from each haul, you would get very much the same result in that way as you would from the present method of counting the fish caught by a special steamer. I do not like to use the word "special" steamer, because I seem to be disparaging them—may I say, by such a boat as the "Garland" or by the Lancashire Sea Fisheries Committee's steamer?

1590. (*Mr. Spring-Rice.*) At the beginning of your statement you mentioned the Inspectors of Fisheries, and you said that the discharge of your duties necessarily involves ichthyological research. Have you ever formulated, since you have been Inspector of Fisheries, any special scientific problem on which you wish for scientific advice?—I have formulated schemes for obtaining information.

1591. Such as getting it from practical trawlers?—Such as getting the raw material from commercial trawlers for the purpose of scientific investigation, and such as the methodical collection of information on a uniform basis from the Salmon Boards of Conservators.

1592. But that is not purely scientific work, is it? I meant, have you ever formulated yourself a purely scientific, let us say, biological problem, on which you desired scientific advice?—Of course, so very much depends on what you call science. It appears to me that science is the acquisition of knowledge by method.

1593. I meant the sort of problem which, conceivably, might be studied in a laboratory?—If I understand your question to mean whether I have drawn up a scheme of laboratory research, I must answer no. I do not think we are at present sufficiently far enough advanced for it to be worth while for me to formulate such a scheme. (*For further explanation of this answer see* 1882 to 1885.)

1594. That is one question I wished to put to you, and then there is another. I see in your description of the means by which information might be got about the sea you have not mentioned lightships. Is there any likelihood of getting useful information by observation

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from lightships?—I think, although I have not put it down that in my oral examination I qualified my written statement by saying I did not mean that special steamers were the sole method of obtaining material for hydrographic observations, but that it could also be obtained from lightships and other sources.

1595. You think it is a point not to be overlooked?—Certainly.

1596. (*Professor Herdman.*) There are one or two points I should like to get your further opinion upon. The first is as to the question of numbers. It strikes me that these numbers you are dealing with are very small; do you consider they are large enough to be analysed in the detailed way in which you have done, and to lead, when analysed, to reliable calculations? I think your total number is something like 20,000 in regard to the greatest number of fish?—I suppose you refer to plaice alone. The total number of the four kinds of fish dealt with is over 90,000.

1597. In the area that I know most of, the Irish Sea, we sometimes catch 20,000 in one haul of the trawl?—Yes.

1598. While this is a total extending over a number of years?—Yes. I think that the conclusion arrived at from discussion of the first proposition which I put forward answers that point. If you remember, before proceeding to discuss whether observations made at one station represented the conditions prevailing at another, I went into the question of how far hauls of the trawl taken at one place afforded a fair example of the fish at that place. The result of the tests which I applied appears to me to show that, although those samples are small, they do afford a fair indication of the fish at that place. But, again, I might perhaps qualify that by saying that although these experiments extend over seven years, results might be obtained in a shorter time if bigger samples were collected.

1599. You do not think the results might be very different when dealing with larger numbers—that is rather my point?—The only evidence which I have got on that point is the evidence which I have given in the discussion of my first proposition, and that shows that they would not.

1600. Then I should like to ask you a question with regard to your third paragraph, where you say that the object of the hydrographic observations is to ascertain the physical conditions under which fish live in the sea. If that is so, does it not follow that the hydrographic observations and the collection of fish must be taken simultaneously?—I hardly feel that I am at the present time in a position to answer that question. But arguing from the analogy of salmon, with which I have greater experience, it seems to me that those observations should be made on a very broad basis. We find, as a matter of fact, with regard to salmon that a good year in one part of the country is usually a good year in another part. Not only that, but a good year in England is a good year in Scotland, and in Ireland, and *vice versâ*, and although you may get small fluctuations, I do not think that those local fluctuations as a rule are worth taking into consideration. But I say in regard to sea fish, I consider that your question is an extremely pertinent one, and that it might be very desirable to investigate that question on the same lines as those I have suggested in regard to salmon, and see whether, for instance, these three years in which we find the great quantity of haddock in the Firth of Forth there was a great quantity of haddock all over the Scottish coasts and English coasts.

1601. Then as bearing on the conditions under which these hauls were taken, you told us about the dates, but you have not given us any information as to whether the hauls had been taken at the same state of the tide—I do not mean by that flood or ebb. What I mean is spring tides and neap tides. Do you not think that that condition of tide, whether the observation is taken during the springs or neaps, would have a very important result?—I have not gone into that question, and, therefore, any answer I could give would simply be a matter of speculation. As I have already explained, I purposely did not go into a number of very valuable observations which the Fishery Board for Scotland have taken with regard to the physical conditions, because it appeared to me that in selecting stations in the North Sea the only information with regard to the physical conditions which we have at present is the nature of the bottom and the depth of water.

1602. Then might I ask you this? In planning the observations, do you not think it would be more important than the mere date of the month to arrange so that the observations should be taken during springs and during neaps, in order that they might be compared?—I am afraid I have not got sufficient information with regard to the quantity of fish taken at these different tides to be able to answer that.

1603. Then there was another point with regard to the same variation you showed us in regard to plaice and dabs on your charts. Is there any information as to the food on the ground?—There is, I believe.

1604. Have you taken that into account?—No.

1605. As perhaps accounting for the variations?—I particularly did not go into that.

1606. There were two stations you contrasted where plaice were more abundant in one end dabs in the other?—Yes.

1607. Do you not think that the difference in the feeding of these two fish would perhaps account for such differences?—That, of course, may be the case, but it would be purely speculation for me to answer, because that is a question I did not go into.

1608. If it could be established that there was more food for plaice on the one ground, and more food for the dabs on the other, might not that smooth out these inequalities, and lead to the results being more comparable?—Quite so; it might do so, but to ascertain where food suitable for plaice and haddock was to be found would entail a survey of the whole of the North Sea.

1609. That brings me to the point I was coming to next. Do you not think it very important that such facts should be ascertained? Do you not think that is quite as important a line of inquiry as the hydrographical conditions and the amount of the fish?—I do not think that I have said anything, have I, to lead to the conclusion that I did not attach weight to all these investigations if it is practicable to carry them out?

1610. No, I did not mean that you had said anything, but I rather felt that that line of inquiry was being omitted?—It is not my intention to omit that line of inquiry. I should like to see all these lines of inquiry followed up, if it is practicable; but, looking to the size of the area to be surveyed, and the limited capacity of each steamer for the work it must in any case take a great many years. It appears to me therefore to be of the greater importance to the English interests that the investigation of those problems which require immediate solution mentioned in answer to Question 1585 should first be carried out.

1611. At frequent intervals during your statement I wrote the words "Query food" opposite them on the note, meaning that what I wanted was more information as to the food on the ground at such places?—Yes.

1612. I felt that that was a factor which appeared to be left out?—It is, no doubt, and purposely left out.

1613. Do you not think it would be very valuable if we could get that information?—Certainly, if we could continue this analysis, if the Committee thought it worth while in order to see what is the effect of all the different factors which have been collected by the Fishery Board for Scotland in regard to these stations. I think it is a line of inquiry which might lead to very valuable results.

1614. You would regard such a line of inquiry as specially valuable, would you not, in the case of the more sedentary fish—flat fish such as the plaice?—With regard to flat fish, I am at present arguing on the result of seven years' observations, and the twenty years in which I have now studied fishery problems have rather shown me that one must not form too strong an opinion on seven years' observations. But it seems to me that these observations, so far as they go, show that the annual fluctuation in the quantity of flat fish taken is less than that of round fish, and further that flat fish are distributed according to the locality. In these circumstances it seems to me that if we want to find out where small flat fish congregate, it is better to collect information as to the actual grounds where the fish are to be found than to attempt to determine the causes which lead to their being found in greater abundance at one place than at another. I do not know whether I have made myself clear.

1615. Yes?—May I give an illustration with regard to that? We know, for instance, in the case of salmon where they spawn, where the young pass the first years of their life, and on that information laws have been framed for their protection at those periods, and we

have not thought it necessary to wait until we found why fish ascended some rivers early and other rivers late, or why some rivers apparently produce a greater quantity of fish than others, and many similar points. Therefore it rather appears to me that on practical grounds the most important thing as regards our English interest is, first of all, to find out the same facts in regard to flat fish as we already possess with regard to salmon, and on which legislation has been based for a number of years.

1616. You have told us that investigations on these lines would afford information as to the size and description of fish frequenting different grounds. That would mean such fish as are caught by the commercial trawler, would it not?—Quite so; such fish as are caught by the commercial trawlers.

1617. So that you would not get evidence with regard to the small fish?—The commercial trawlers do catch what are considered for all practical purposes small fish.

1618. But there are still smaller ones?—There are some still smaller ones, and we could not get information with regard to them, but I think, if we got the information which I have indicated it would help us very considerably in our present difficulties.

1619. You do not think we require further information. You also told us that they would comprise the investigation of those points of immediate importance on which early information is urgently needed. Do you not think we require information as to the very small fish?—I think we require all the information we can get, but I think for the moment what we require is to know what damage is being done by trawlers on what are usually known as small fish grounds.

1620. And you think we can get that fully enough from the results of the commercial trawling?—I should hope so, if we are able to get the material which I have indicated from the trawling fleets and from a sufficient number of reliable skippers.

1621. Yes, but only making use of commercial trawlers?—Yes, only making use of commercial trawlers.

1622. I am thinking rather of the implements than of the men, which are employed in catching. Would you get your information in the first place from the commercial trawlers?—Yes.

1623. And in the second place from hydrographic observations made by special steamers—that might be a part of your information?—Yes.

1624. Do you not think you would also find it desirable to get information as to the biology of the sea bottom, which could be obtained by neither of those methods?—I do not quite understand why the biology of the sea bottom may not be obtained by your special steamers.

1626. Well, did you contemplate that it was to be obtained by the special steamers—I did not gather that?—In the last paragraph of my statement you will see that I suggest that the examination of particular areas might be made by these special steamers for the collection of bottom deposits, fish food, fish eggs, and such fish as are not taken by the commercial trawlers.

1626. But my point is: Would that be compatible with the hydrographical work? Would not that have to be taken where the commercial trawlers were working, and not on the lines along which you desired to have the hydrographic observations?—I think it would depend on the information. For instance, information with regard to fish eggs might be obtained along the lines where the hydrographic observations were made.

1627. My question did not refer to fish eggs. My question referred to the bottom biology, the nature of the bottom, the food, the non-marketable fishes, the youngest stages of the marketable fishes?—Whether that would be required from the places where you get your returns from commercial trawlers—is that your point?

1628. Yes; and also further whether it would be satisfactory to get it along the hydrographic lines, or whether that would be insufficient?—It would certainly not be sufficient to get such information along the hydrographic lines. But, for the reasons that I have already given, I do not consider it essential, at any rate at present, to get it from the places where you get your returns from the commercial trawlers. My object in proposing to get material for the investigation of those problems which require immediate solution from commercial trawlers is to collect it on such a large scale that one would know the place—the locality—which different fish frequent rather than the reasons why they frequent those localities.

1629. I do not suggest you should get it everywhere where you have the commercial trawlers. My question was rather whether it would be sufficient to get it on the hydrographic lines, and I gather your answer to that is: "No, it would not be sufficient"?—That is so.

1630. (*Professor Thomson.*) I should like to refer to one or two points. You picture the possibility of a special steamer getting over the trawlable ground of the German Ocean—getting over per annum only 17 square miles of the trawlable ground?—Yes.

1631. And then when you are contrasting with that the use of the commercial trawlers, you picture that these commercial trawlers cover the whole area twice over in the year?—Quite so.

1632. Now, that is only an illustration, you said, but it is not quite a fair one, because, as you know the trawlers go back to the same place over and over again. They go back to favourite grounds, and they do not try to traverse the whole trawlable area of the German Ocean?—No, but I think that if you get information with regard to those grounds which were frequented by the trawlers you would, for all practical purposes, get all the information that you required. If the trawlers do not go to a certain locality it really does not signify whether the fish are big or little in that locality; you would not want to protect the fish in that locality against trawlers.

1633. Still, by the one method you picture a ship covering 17 square miles?—Yes.

1634. And by the other method you picture the whole trawlable area gone over twice a year?—I think if you will take the context you will see that the one statement does not refer to, neither is it contrasted with, the other. In the one case I am referring to a special steamer which must necessarily visit selected stations at certain stated periods, whereas in the other I am referring to the collection of information on a very much broader basis, and not in the same detail. In both cases I give the facts, which speak for themselves.

1635. (*Mr. Spring-Rice.*) I think your figures become consistent if it is put in this way: In one case you contemplate 17 square miles being trawled 12 times a year, and in the other 100,000 square miles being trawled twice a year?—That is so.

1636. (*Professor Thomson.*) In reference to your Firth of Forth observations, which show great fluctuations, have we not some real reason for believing that as you go further out away from the estuaries altogether to the open sea, there is to some extent a greater physical uniformity?—I do not know of any data to that effect.

1637. But if it be so, if there are such data, it would rather weaken the argument which might be deduced from the great fluctuations in your Firth of Forth observations?—I do not put forward the analysis I have made in any dogmatic spirit. It is simply the only material to which I have at present had access. If further information can be brought forward showing that the conditions in the open sea are more uniform I should be quite prepared to consider it. The question is one on which I have quite an open mind.

1638. Did I understand you to say that you doubted the utility of a special ship for hydrographic purposes, that you doubted whether it had proved its case as yet?—I do not think I expressed anything that at present amounts to a doubt. I said that as far as I have at present had evidence, it has not been proved that hydrographic observations made at one place represent the conditions over a wide area, and that it is a point upon which I think further evidence is required.

1639. Then you think the Ingolf expedition has not proved itself of real utility in connection with fisheries?—I am not acquainted with those investigations; but if they do throw light on the question of the value of samples I think it would be very desirable that the results should be placed before us.

1640. (*Mr. Spring-Rice.*) Were any of those stations actually fished apart from the "Garland"?—Yes; I ought to have mentioned that Stations VIII. and IX. were outside the closed area; all the rest are within.

1641. (*Mr. Pelham.*) How much was in the three-mile limit?—It is the Moray Firth that the trawlers are accused of going into, and not Firth of Forth?

1642. But they could go in?—Yes, they could.

1643. It is a ten-mile limit; you get it somewhere *here*, do you not?—Yes, *that* part is closed for all purposes.

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1644. (*Mr. Crawford.*) You are director of the British Rainfall Organisation?—Yes.

1646. And you were formerly chemist and physicist to the Scottish Marine Station?—Yes.

1646. I believe you have devoted much time during the last 20 years to physical research in the sea?—Yes, I have.

1647. Both in connection with biological and economic questions?—Mainly in connection with physical, but with biological and economic aspects; not directly biological or economical.

1648. Are you also acquainted with the work of that description which has been carried on on the continent?—Yes, I know that fairly well.

1649. I believe you were a delegate from this country to the Christiania Congress on the scientific exploration of the sea?—Yes. I was one of the delegates.

1650. I believe that you are prepared to express to us some views on the questions which are referred to this Committee?—Yes, I am mainly with regard to physical observations; that is what is called on the Continent hydrographical observations. On that subject I have thought a good deal, and I have certain fairly definite views.

1651. Perhaps you will be good enough to tell us what they are?—I take for granted, to begin with, that it is acknowledged that the physical conditions of the water do have a determining influence on the movement of life in the water, and that being so, the important thing, to my mind, is to determine first the normal series of changes in the physical conditions of the water, that is to say, the temperature, the salinity, the variations in the chemical composition, and very particularly the variations of the dissolved gases. These should be determined at frequent intervals so as to enable one to form a picture of the changes that take place from month to month throughout the year, and when a sufficiently long series of observations has been made to enable us to form an idea of the normal changes, then to continue making observations to investigate any abnormalities that may occur. In every case one should bring these into close connection with the statistics of fisheries, extended, if necessary, to correspond with the areas where the investigation is being carried on. The value of these physical observations is very much enhanced by having them made simultaneously, or as nearly simultaneously as possible, over a very large area, not only along our own coast, but throughout the whole breadth of the North Sea, also to the north of the British Islands, right up into the Norwegian Sea, and as far as possible westward towards and into the Atlantic. If these observations could be made with fair regularity in the seas all round the British Islands, then we would be able to form an idea of the seasonal march of physical change in the sea-water; we would be able to form an idea of where the sea-water come from, whether at one time we were entirely surrounded by Atlantic water, or whether a considerable proportion of Arctic water, or of Baltic water was mixed with it. Having ascertained the normal conditions, we could then specially investigate those seasons in which one or other of those waters of different origin predominated over our area, and ascertain whether there was a corresponding change in the fisheries.

1652. You give prominence at first to the North Sea and to the sea extending north from that, but I understand you to say that it would be very important to get that hydrographic information for all the sea that surrounds the British Islands, including, for example, the English Channel and the Irish Channel?—Certainly it would be important, but for a special reason I consider the North Sea at present is more important, that reason being that the simultaneous observations would be carried on in collaboration with all the other maritime countries in Europe, with the exception of France, I believe. They, of course, would work only on the North Sea, on the eastern side of it, and in the Norwegian Sea. Then our work in the North Sea would fit in with theirs, and any further work which could be done in the Atlantic would undoubtedly have a very important bearing. The whole thing must be treated as a whole, and not as parts. That is really the main feature which has to be recognised. The method of working which has been elaborated by the Conference at Stockholm and approved by the Christiania Conference I think is, as far as the hydrographic work is concerned, fairly final. I do not think we can improve upon it. The only point is whether it would be found possible to carry it out with the detail and with the technical exactness that that programme demands. That, of course, is mainly a question of funds. If the funds are forthcoming the scientific work can very easily be done. For that work it would be, in my opinion, absolutely necessary to have special vessels, not for the hydrographic work alone, but to do the hydrographic work at regular times, and to be employed at other times, equally regular it might be, in doing any biological or economic work that would be required. But the point upon which I feel strongly is that it is no use trying to do this work by means of gunboats lent by the Admiralty, because those vessels were not intended for that work, their officers and men do not usually understand it—occasionally when you find an officer who is interested in the work you can do a good deal, but as a rule (and I speak from some little experience) the results are not very satisfactory. It would be necessary to have a specially-equipped vessel, the first duty of whose officers and crew would be to carry on these scientific investigations.

1653. And how many vessels do you consider would be required in the first place for taking a proper share by this country in that examination of the North Sea?—So far as the North Sea is concerned the work could be done, I think, very well by two vessels, but if the Atlantic is also to be brought in it would be necessary to have a third. I do not think the work could be done satisfactorily and fully without three vessels. They would not require to be all the same size, but one would need to be a good strong sea-going vessel that could go out in the Atlantic in ordinary rough weather, which would stand a moderate gale without being afraid.

1654. They would all require to be tolerably stout vessels, would they not?—Yes, of the type of a large trawler; that would be the minimum size, I should say.

1655. Then I think you have some observations in passing at all events to make upon the want of success hitherto in that direction?—Yes. I do not want to express myself too strongly on the subject, because much of the work that has been done has been purely pioneer work, and from it we have obtained a certain amount of experience. But still the work that I am acquainted with which has been done in this country has been spasmodic and local, here and there at different points on the coast, and I do not think that the officials who have had charge of that work, the fishery officials on the coast of Scotland, for instance, have fully realised the importance of it. They have not been in all cases adequately instructed to begin with; they have done the work without quite understanding it, and a system of inspection which has now and again been started, has never been sufficient to keep the thing going in a thoroughly satisfactory state.

1656. To what part of the work in Scotland do you refer. They have only got one boat there?—Yes. I am referring not to the boat at this moment, but to the work done for some years (I am not sure whether it is continued now) at various stations on the west and east coasts. Instructions were given to the keepers of lighthouses and lightships and to certain fishery officers at various points on the west coast, and they kept the temperature of the water and in some cases the densities of the water for several years I know.

1657. But you do not consider that any really very important or valuable results have been obtained from that?—There were some interesting statistics brought forward as the result, but the results were not sufficiently trustworthy to be applied as rigidly as one would wish.

1658. Has anything been done in England, are you aware, in the same direction?—Something was done about fifteen years ago in supplying thermometers to a number of vessels in the trawling fleet. The Rev. C. J. Steward, who was then at Somerleyton near Lowestoft, took a great interest in it at one time, but I think that died down. I do not think it is continued now.

1659. Are you aware whether anything is being done in Ireland?—I believe some work has been done recently on the coast of Ireland.

1660. But I understand you express the opinion to us

that the proper method of obtaining this hydrographic information which you think is of great importance, as bearing on the sea fisheries, as a national industry, the proper method of doing that is to have special steamers for the purpose, and to work it on an international scheme?—Yes, that is so; that is for work at sea. They could be supported to a very considerable extent by work along the coast.

1661. They could?—It could be supported. The work along the coast is not in itself sufficient, but it would be very valuable in filling up the gaps in the work at sea.

1662. Now how would you suggest that the work along the coast should be prosecuted?—That rather involves the same large question of the general direction of the whole work, and it seems to me that to make the work at sea practicable it would require to be under one general direction for the whole country. But the work along the coast at the different harbours, and perhaps on selected fishing boats, might very well be conducted by local authorities acting under the instructions of the central authority and reporting to it. Of course I do not suppose that it is likely that the constitution of the scientific work would be determined by the physical observations alone, and these could, to a certain extent, be adapted to the constitution that is found advisable with regard to the other work—the biological and economic. But if it were decided to have one central authority, one central board of marine investigation, for the whole country then I should say certainly they should have the supreme direction of the work, but the details in carrying it out in different localities might very well be entrusted to local boards if such exist.

1663. Would you regard the international system of investigation as a permanent or a temporary organisation?—I would regard it certainly as temporary on its present basis, because it only contemplates investigations for five years. At the end of five years it is very probable they will find five years more are desirable; but I should say that after ten years it would be quite possible to get a very fair idea of the normal conditions of things. The further you go from shore the more uniform the conditions are.

1664. The point, it appears to me, has some bearing on the question as to how far the fishery authorities in this country should be centralised, because opinion as to the desirability of that might be affected by the fact that we are going to be partners in a scheme of investigation with other countries?—So far as we would be partners with other countries we are fulfilling a minimum programme which leaves us free to do anything further which would be to our own advantage. We do not limit ourselves in any way by associating ourselves with the others.

1665. For example, I suppose we should only be associating ourselves with the others according to the present programme in the North Sea, whereas we should be, I suppose, expected to do something for ourselves on the west side?—As a matter of fact, if we did anything on the west side I presume it would be reported to and utilised by the central international authority, though at the same time it would be of more immediate utility probably to ourselves.

1666. I think you are disposed to sum up your view of the case by saying that it is important that we should co-operate in this international programme?—That is my feeling very strongly. I think we have usually failed by not going far enough, not making the thing complete, and especially with regard to the North Sea. To my mind it is absolutely essential that we should know the condition of the work on the east side and the west side of that sea.

1667. Of the North Sea?—Yes; and that we should know the sources of the water and the movements of the water and the fish that are in the water.

1668. You have a very strong opinion as to the probable importance of that information on the fisheries as a national industry?—Yes, I have, very strong, though not founded on statistics. I do not feel prepared to give a reason for it, but the feeling in my mind is very strong.

1669. The importance of that question is quite independent of biological observations?—Not independent of biological observations.

1670. I did not mean exclusive of them?—I think biological observations without hydrographic observations would be of little value, but the hydrographic without biological would be of no value at all as far as the fisheries are concerned—they must go together.

1671. (*Mr. Pelham.*) Are you acquainted with this report of Dr. Hjort of the "Michael Sars"?—I have looked at it; I have not read it.

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1672. A question was raised as to the chart in that report. I think you will see the lines of the route where the experiments were taken?—Yes.

1673. Between those two routes there is a very large area covered dark blue, which shows a certain density, I presume?—Yes.

1674. How would he arrive at that—merely from what he found the direction of the current to be to the north, and the direction of the current when he was down south, or how would he arrive at the condition of the intervening area?—This chart represents the conditions between July and September, and I have no doubt he utilised in it the observations that are being made by the Danish and the Norwegian trading steamers. The Danish steamers running to Iceland and to the East Greenland coast take observations during their passages, and I have no doubt they were incorporated with the actual work of the "Michael Sars" so far as the surface is concerned. This simply refers to the surface.

1675. Do you say that the currents in the North Sea and the temperature of the water would be more uniform than along the coast, or would it be otherwise?—I think it would be more uniform than along the coast on account of the disturbing influences of the fresh water. When a river comes down in flood it produces an effect upon the sea which varies with the nature and volume of the river.

1676. Would not the ice have a greater effect on the northern part of the North Sea at any rate than it would on the estuaries?—The North Sea in the ordinary limits, north to the Shetlands, of course, is free from ice. I do not think the ice ever comes out of the Baltic, or at least only in very small quantities.

1677. I suppose icebergs from the Arctic zone go down a considerable way, do not they in the early summer?—I do not think they go, as far as I am aware, to the east of Iceland; I think they pass down to the west of Iceland. The ice is usually in a line from Iceland north-eastwards to Franz Josef Land.

1678. Would the currents, from whatever cause in the North Sea, vary in direction according to the time of the year?—I should think they certainly would.

1679. And according to the lateness or otherwise of the season?—Very largely on account of the prevailing winds of the previous three or four months.

1680. You attach importance, I understand, to the ordinary trade statistics?—Oh, certainly.

1681. And you think that if possible they should be improved?—I do, and brought into relation with the physical observations.

1682. Would you form your conclusions as to the actual population of the sea from the trade statistics, or from the takes by special boats?—I think I would take both into consideration.

1683. Then as regards the takes by the ordinary trawlers. I suppose it would be rather important if you could connect the hydrographical observations with those takes?—Yes, but I think that would be done sufficiently without having observations made on board these trawlers. If we have the observations regularly at a given interval of time, we can learn the period at which the change between the two observations has taken place, and we can form a picture of the changes over the whole area, and have a fair idea of the conditions at the particular time of the catch of the trawl.

1684. If you had evidence that a trawler or trawlers had had very large catches at a particular spot, it would be very desirable, if possible, to have some idea of the temperature of the water at that particular time, would it not?—Yes, not necessarily at the particular spot, but the general distribution. For instance, it might be that they had a special catch along a certain line: that line might be a meeting of waters of different origins, or something of that sort, which would be brought out by the general investigation.

1685. Is it not the fact that the temperature would vary very often within a very short distance?—Yes, that is just one point that indicates that the water of different sources is coming together without absolutely mixing. Of course, it mixes gradually. Very often you get water of two different origins side by side for a considerable time, and it is important to find that.

1686. Now if it were possible it would be important to get your temperature and your observations as to the salinity, and so on, at the same time as the fish were

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caught?—That would be desirable if possible, but it is not essential, not so essential as getting it before and after, to see if there is any definite change in one direction.

1687. I suppose before you can arrive at any conclusions on these important questions, such as depths, temperatures, salinity, currents, and places of origin, and so on, you would have to take observations over a considerable time?—Yes, certainly; I should say five years is an absolute minimum.

1688. Would it not be possible to arrive at some legislation or international arrangements even before you had concluded all those observations?—That is rather a matter for international diplomacy than for scientific study, I think.

1689. What I meant was this: If you ascertained that there was a very large number of undersized fish at a particular bank, the time might be ripe for some legislation or some international arrangement before you had arrived at the reasons why this bank was frequented by the smaller fish?—Quite so, but that is going outside my province, which is simply the physical observations. I think there are other ways of handling the subject, certainly.

1690. I suppose the specially-fitted vessel used for hydrographic experiments you would also use for trawls?—Yes.

1691. Both in order to ascertain what fish there were and also to ascertain what the nature of the bottom was?—Yes; I think that could be done perfectly easily.

1692. (*Mr. Archer.*) Are the hydrographical conditions in the sea fairly constant?—Well, they are in certain parts of the sea. If you take the Central Atlantic they are very constant. The "Challenger" observations in deep-sea soundings have been repeated at long intervals, and but a fraction of a degree of difference was found at depths below fifty fathoms. Of course, surface layers of water change very much with the wind.

1693. That is as regards one place with another?—Yes, and as regards one place with itself at different times.

1694. (*Mr. Spring-Rice.*) For hydrographic purposes do you think much use could be made of lightships?—Occasionally I have found the people on lightships very intelligent, and doing very well.

1695. You were saying you wanted to know about the temperature and other physical conditions of the water coming up Channel?—Yes

1696. There are lightships pretty close to the narrowest part of the Channel. Could you use them to make a series of observations which would be of importance from your point of view?—As stations they would be extremely important. The only difficulty is the practical one, whether the men could be induced to take the observations with sufficient care.

1697. But most observations would not be ones which would require very great scientific skill?—No. If you have a man of thorough honesty, and instruct him at the beginning and get him interested, the work could be done admirably.

1698. In the same way in which in land meteorology so many valuable observations are taken by gardeners?—Yes, but we do not trust gardeners' observations by themselves. We take them as they are related to others in the immediate neighbourhood, and check the one by the other.

1699. Do you think much valuable information for your purposes could be got from casual ships, or, still more, from regular liners?—From regular liners, for the purpose of connecting one part of the area with another, I think observations are most important.

1700. For instance, vessels going from Hull to Bergen?—That would be very valuable indeed.

1701. We know that the Meteorological Council attach considerable importance to the observations they get from the Atlantic liners?—Yes They work them up, and some of the captains do those observations admirably.

1702. One other subject I must ask you about. I see you recommend a central authority for the United Kingdom for the purpose of carrying out this international work. Have you any ideas in your mind as to the sort of authority you would desire that to be?—No. That is a question which I am afraid is too difficult for me to form any definite ideas upon. So much depends upon the source of the money by which the thing is to be done.

1703. Supposing most of the money was voted by Parliament?—In that case I think it would be desirable to have a sort of council, a council of marine investigation, or something of that kind, who would not themselves have charge of the actual economic work of any department, but be purely scientific.

1704. Would your idea be a board mainly of scientific men, or merely of practical people carrying out a prescribed programme?—You would require to have at least some scientific men on the board, because of course, it might be possible that the programme would have to be varied from time to time. But it is very important that there should be practical men too.

1705. The idea one gathers from the Christiania report is that the programme was to be dictated by a central scientific body which was to be at Copenhagen?—Yes, that is quite true as regards the method of working and as regards the trips four times in the year, but if special ships were provided they would have a very large part of their time not accounted for, and there is certainly abundance of useful work that they could be occupied in, and they would require some direction in order to enable them to carry on work between the international trips.

1706. So that you would have some sort of committee, mixed practical and scientific?—Yes. I do not like to contrast "practical" and "scientific," altogether.

1707. The same man may be both practical and scientific, of course?—Yes. I think it is important there should be some business man on the committee who would be able to look after the finance.

1708. And there would be a large number of administrative questions obviously?—Certainly.

1709. If you have ships you would have to see about all sorts of things—for instance, coaling and provisioning them?—Yes, certainly. You would have somebody who was accustomed to deal with shipping.

1710. That is your sort of idea of a central authority?—Yes, that is my idea.

1711. It would be a central authority *ad hoc*, not to administer the laws affecting fishery matters in the three kingdoms?—I think it would be desirable to keep these separate to a great extent. Of course, it would depend a great deal on the way in which the fishery organisation was treated. If the fishery organisation were left as it is now, or substantially as it is now, with the three countries under separate administrations, then I think a central authority would be extremely important and most essential, so that there should be uniformity in action by all three.

1712. Do you think it would be a workable plan to have a central authority simply for the purpose of the international scheme of the five years' programme of Christiania, and matters arising out of it?—Yes, I think it would.

1713. And not touching on the questions of local law?—I think it would be very desirable if the scientific could be kept apart from the legal aspect of it in every way.

1714. (*Professor Herdman.*) You said, I think, that it was desirable that hydrographic observations should be taken at frequent intervals?—Yes.

1715. In order that we might be able to trace the changes from month to month. You are aware that the Christiania programme only provides for quarterly meteorological trips?—Yes.

1716. Would they give you sufficient information?—No, I think we ought to fill in the intervals between the quarterly trips. I think quarterly trips are not sufficiently frequent for detailed work. They would give very valuable information as regards the origin of the water entering the North Sea, at different seasons of the year, but not sufficient, to my mind, for our management of the fisheries along the coast. We should want it very frequently.

1717. You think we want more hydrographic work than is laid down in the Christiania programme?—For our own purposes, yes.

1718. Have you formed any scheme, even in your mind, as to how long it would take the vessel on each occasion when it went out to conduct a series of observations?—No, because as yet we have no data. We do not know how far the other Powers are going to carry

on their observations. We have not really decided what lines will be taken.

1719. I think we have in some cases. Has not Sweden published a detailed proposal?—Yes, they published a proposal, but it was not quite definitely fixed not so definitely as the other parts.

1720. Then you think we are still quite in the dark, or, at any rate, our ideas are vague, as to what will be done on each trip, and how long the trip would take?—With regard to the quarterly trips, if we had two ships working in the North Sea and the English Channel, say from Shetland to Cornwall, I should say it would probably take about three weeks' work for both ships to do the routine of the quarterly trip.

1721. You think the ship would make the round in three weeks?—I think so—something like that.

1722. Are you allowing at all for bad weather?—The work can only be done if the weather is fairly good. If it is very bad weather, of course it is interfered with.

1723. What about the simultaneous nature of the observations?—They must be made as nearly simultaneous as possible. You cannot get absolute simultaneity, of course.

1724. Can you give us any idea of what amount of simultaneity is required?—A good deal will depend on the result of the observations themselves, when we find whether the changes take place rapidly or slowly. You see it is conceivable that the greater part of the change of a year might take place in a jump; in a single week the temperature might change ten degrees, and change very little before or after. On the other hand, it might take place extremely gradually, in which case you would have a much longer time without having serious error. We do not know quite enough yet.

1725. You do not think we have sufficient information yet to say whether it is necessary that observations should be taken, say, within a week in order to be comparable, or within a month?—We have sufficient information to say that it is extremely desirable that all observations should be taken on the same day if possible, but within a week is the next best if we cannot have it on the same day, and within a fortnight if we cannot have it within a week. I think a fortnight is the limit I should put in my own mind as that which it would not be wise to exceed.

1726. You think two boats could undertake our area, the area which has been assigned to Britain?—Yes, if we leave the Atlantic out of account.

1727. Of course, you are only dealing with hydrographic observations?—I presume plankton work could be done at the same time. There would be no difficulty about that. And in returning from the trip, probably there would be opportunities for trawling. It depends on how they are planned. My idea would be to start both vessels from a central point and proceed towards the extremities. The other idea would be to start from the extremities and proceed towards the central point. It would depend very much on practical considerations which would be done.

1728. Now, to go to another point of a different nature; the observations which have been made of this nature, the Scandinavian observations, for example, are made in great detail, are they not?—In the Baltic they have been made in very great detail, certainly.

1729. I mean to a very great degree of accuracy?—Yes.

1730. Going to the fifth place of decimals?—In densities, yes.

1731. And in salinities?—I am not quite sure whether that is necessary.

1732. I was going to ask you, do you consider it necessary?—I do not consider it necessary to go to the hundredth part of a degree Centigrade, as they have tried to do, but all attempts towards accuracy are laudable.

1733. Do you not think some of these are non-significant figures?—Of course, the only advantage they have is that they make the significant figures perfectly sure, but I do not think myself that you need to aim at anything closer than the tenth of a degree Fahrenheit.

1734. You have had practical experience yourself of taking observations at sea?—Yes, I have.

1735. What do you think is practicable, taking rough weather?—I think the tenth of a degree Fahrenheit is a good practical thing, and is as close as you require to go.

1736. And as to the densities?—That depends on how the densities are determined. If they are determined on board ship you cannot get them very exact.

1737. I am speaking of those determined on board ship in the first place?—That can only be very rough work, and I doubt whether there is much value in trying to do that at all on board such ships as would be provided for this purpose.

1738. At all?—It would be only in very smooth weather that the observations could be made. I think it would be preferable to take samples of the water home, and have the work done in a laboratory.

1739. By the bnrette?—Yes, or by the hydrometer—probably by both, one as a check on the other.

1740. Going now to the laboratory work, what degree of accuracy do you think we can go to there?—There you can certainly go to the fifth place of decimals in densities.

1741. The next point I wanted to ask you was this: Have you any reason to believe that waters differing to that degree have any practical effect upon the distribution of the bottom fish?—I think that the Swedes are inclined to place too much dependence on small differences. I certainly think that. I could not speak with any authority as to the action on the fish. That is one of the points that I think we want to have brought out by biologists.

1742. I mean if you have information—I do not know whether it is within your own knowledge or not—that bottom fish move about into waters which differ in the first and second places of decimals, move about freely in it, and migrate into it freely and out of it again, would you attach much importance to the influence of changes in the water in the fourth and fifth places of decimals?—I do not know whether that would affect fish. It is another question whether it might not affect plankton, and that would affect the fish indirectly.

1743. I am talking of bottom fish—feeding on the bottom?—I do not remember any investigation with regard to that at this moment.

1744. To go back for a moment to the work on the vessel at sea, do you consider these observations would have to be taken by scientific men?—They would have to be taken at any rate by men who had been trained by scientific men, and were subject to frequent inspection. The actual reading of the instruments can be done by any intelligent petty officer.

1745. You think it might be entrusted to a mate?—Yes, or a boatswain—an intelligent man, such as a petty officer in the Navy. They can do the work perfectly well, but they require to be under supervision. It would be desirable to have a scientific man on board the ships during the cruises, certainly.

1746. Then, coming to another point, do you contemplate in the scheme which you have in your mind that the steamers on which the hydrographic observations were going to be taken would be able to do bottom biological work also, such as dredging and trawling?—I think they could; but I do not think they could attempt to do it at the same time.

1747. I meant at the same time?—Not on the same day.

1748. Not simultaneously with, or on the same localities as the hydrographic observations?—It would depend very much on the amount of work they had to do. If they had to take three temperature soundings every day at 10 or 15 miles apart, I do not think there would be much time for taking trawls in between, but, in returning or going to the stations, then they probably would have sufficient time.

1749. A further point was this: what degree of importance do you attach to the lines which were laid down for the hydrographic observations—supposing they were quite unsuitable for biological observations, or, at any rate, were not the points at which we wish to have information?—I should think these lines might be capable of modification, because, after all, though they are drawn as lines, they are really chains of points For instance, if you have two lines going from east to west, their place might be taken perfectly well by three or more lines going from north to south.

1750. Can you tell us why these lines were chosen?—No. That was done at the Stockholm Conference. At the Christiania Conference the matter of the lines was not looked upon as of sufficiently pressing importance.

1751. Looking at the lines, and with your knowledge of the hydrography of the North Sea, do you see any

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reason for those lines?—My feeling is that what we ought to try to do in the North Sea is to take observations across all the entrances to it, so that we can keep an account of all the water that comes in and goes out, and then have certain lines cross in different directions the body of the sea, to see what changes are occurring there. And that we shall do, not so much to ascertain what is happening at the moment, but to get a sort of current account of all the changes that take place, from which we would then be able to deduce the condition of any part at any time, and apply that condition to the fishery statistics. That is the idea I have in my mind.

1752. In the interests of our own British fisheries, supposing you had the two steamers which you have spoken of placed at your disposal, would you put them into the international scheme, or do you think you could arrange other lines that would give us information of more importance to ourselves?—I feel very strongly that it is desirable to carry on work in uniformity with that of the other nations, because if that is not done we should lose the whole of the benefit of the work which they are doing, and, of course, they would lose the benefit of our work. But taking it from our own point of view entirely, I think we should gain much more from being able to utilise their work than we would from having a scheme which, in certain details, was better, but which was peculiar to ourselves.

1753. You think their work has a distinct bearing on our interests?—I think so very decidedly.

1754. (*Professor Thomson.*) May I ask your opinion on this point: Do you think we have in Britain a body of available experts in hydrography at all comparable to what we should secure if we entered into this international co-operative scheme?—I am very much afraid that we have not, because since the proposal was first started on the Continent a number of people have taken it up with great enthusiasm, and they have formed regular schools of marine scientific work, such as we ought to have had in this country by this time, but which we have not developed to the same extent. There are more young men, more students, capable of doing the physical or hydrographical work on the Continent than there are in this country at the present time. As to the biologists I am not competent to speak, but we could in a very short time get people trained for the physical work. There is no difficulty about that. That is one of the best points of the international scheme, that they would have a central laboratory in Christiania, in which men could be trained to do the work.

1755. (*Mr. Crawford.*) Is there anything else you would like to add?—I do not think there is anything else. I think my views have been very fully put forward.

SEVENTH DAY

Tuesday, 21st January, 1902.

PRESENT:

The Right Hon. Sir HERBERT MAXWELL, Bart., M.P. (*Chairman*).

WALTER E. ARCHER, Esq. | STEPHEN E. SPRING-RICE, Esq., C.B.

R. E. MARTYR, Esq., *Secretary*.

Mr. W. GARSTANG, called; and Examined.

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1756. (*Chairman.*) You are the naturalist in charge of the fishery investigations of the Marine Biological Association at Plymouth?—Yes.

1757. Have you any recommendations to make as to the development of our fisheries and ichthyological research generally?—Well, I think there is a great field for more scientific observations on matters connected with our sea fisheries.

1758. First as regards machinery, have you any suggestions to offer—is the existing machinery adequate?—In my opinion it is quite inadequate as regards the resources available—it is impossible to carry out adequate researches at sea without steam fishing vessels, and those are at present entirely wanting except as regards Ireland, I believe. Also it is impossible to carry out the work properly unless there is a larger number of scientific men devoting their attention to the subject, able, that is to say, to work up the results and material which is collected by the steamboats to be engaged.

1759. Would you advocate a central department for the three kingdoms, or would you rather maintain the present separate departments in these matters?—As far as I understand at present there is no English department—no scientific department—and that would appear to be the first gap to fill up, namely, to institute a scientific department for England, and instead of sweeping away the existing system, which has worked to some extent well in the past, to adopt some method of co-ordinating the work between the three local, or, if you like to call it, national scientific departments.

1760. Do you recognise any object in maintaining three departments separately?—To my mind it is almost immaterial except as regards the administrative work. There are administrative differences between England, Ireland, and Scotland, and especially between Scotland and England at present, and unless fresh administrative methods are contemplated I suppose it would be convenient to have the scientific departments separated. Otherwise I am quite indifferent as to whether there is a head scientific department with local branches, or whether the three local scientific departments should be co-ordinated. It seems to me to be of less importance for the scientific work (leaving out the question of administration) than the provision of a sufficient number of steamers and naturalists to carry out the scientific work. There is another point also in regard to Ireland. The use of scientific research in connection with the Irish fisheries would appear to be of a different character from the use which the scientific work would have in connection with the Scottish and English fisheries. The Scottish and English fisheries are stated to be suffering from over-fishing, rightly or wrongly; but no one alleges that as regards the Irish fisheries, and the work of the Irish fisheries department would be in the way of exploiting and searching out new methods of fishing and, in a sense, encouraging the local men, the Irishmen, to fish more than they do at present.

1761. England and Scotland are stated to be overfished, and you want scientific men for England and Scotland?—Well, it is rather to investigate matters connected with over-fishing and in order to advance the general cause of fish culture which at present is almost non-existent as regards sea fisheries. Therefore, on these grounds it would appear that there is something to be said for maintaining a national difference. I mean basing the scientific organisation on a basis of the three nationalities. If there was no administrative difference at present existing as between Scotland and England, I think I would recommend a different grouping of the scientific bodies, but in view of the administrative differences it would be the simplest and easiest way simply to create a new scientific department for England, and to devise machinery for co-ordinating the work of the three branches.

1762. Would you effect that co-ordination by the creation of a fourth body?—No, on the whole not. I should be inclined to think that it would be sufficient if the heads—if the superintendents of the scientific departments of Scotland, England, and Ireland were to meet regularly in an official manner under an impartial and properly qualified chairman. The risk of leaving the co-ordinating work to the superintendents would

appear to be this: supposing one of the superintendents seemed to be keen only on a particular branch of inquiry, he might veto any sufficient co-ordination. But I should think it would be sufficient to have an impartial chairman to give their deliberations a co-ordinating character. I do not, off-hand, see the necessity of creating a separate scientific board or department above the English, Scotch, and Irish Departments.

1763. From the point of view of science, do you recognise any advantage in the arbitrary division into three bodies of the scientific department?—Apart from the scientific work?

1764. So far as regards the scientific work, is there any advantage to be gained by maintaining the national distinction between the three branches of the department?—Only this advantage, that there must be local headquarters in different parts of the United Kingdom There must be a local laboratory, a depôt for the naturalists in the northern region, at any rate, and also in the southern region, and also in the western region; and on the whole those coincide with the national distinctions. That is the only point that seems to me of any importance.

1765. That would not be incompatible with one central department?—No, and there would be certain advantages in having a central department and the local laboratories under the direct control of that central department, because local influences to some extent would not work so strongly. A single scheme of work would be carried out without any hitches. But in the summary which I was asked to send I thought that it was easier to build up a new department for England and to arrange the final co-ordination of this as the result of some years' experience. But I see no great advantages one way or the other for the carrying out of the scientific work.

1766 You suggest the formation of a national museum?—Yes.

1767. What have you in view when you suggest that—education in fishing?—That was one reason; another reason was that specimens of fish which from time to time are concerned, as it were, in Parliamentary differences might be stored up there and be available for comparison. I might say that the museum would to some extent be used as an illustration of any legal enactments that should come to be made. For example, supposing legislation as to the size of fish to be caught—I fancy it would be useful to have a central museum in London where specimens of the different fishes concerned in such legislation should be stored up and their whole life-history illustrated, together with specimens showing, for example, the size that Parliament has fixed—the limit of capture.

1768. Surely that is rather a modest aim for a national museum?—I was only mentioning one. I think that the national museum might illustrate the whole distribution of sea fishes round the coast, just as in an ordinary natural history museum the fishes or animals are put into bottles and displayed, and at the same time arranged on a system showing the chief points in their life histories and geographical distribution. I presume that would be useful. At the same time I do not attach nearly so much importance to the museum as to the provision of means for getting new work done. I think that many special points connected with the technical education of fishermen are likely to arise in the future, and that a museum would certainly be a useful institution in connection with technical researches.

1769. The Department of Agriculture is the same for Scotland and for England, is it not; one department administers agriculture both in Scotland and in England?—I understand so.

1770. Do you see any reason why the fisheries should be on a different footing?—I should very much prefer that they should be on the same footing.

1771. I think you advocate the putting of the fisheries under the Board of Agriculture?—Just to save the creation of a new separate department, which would have rather a limited field for its work; but if a new Board should be created united with the Board of Agriculture of Scotland and England I think that would be a very satisfactory solution.

1772. (*Mr. Archer.*) I see that you recommend that the English department should have a sea-going steamer. Have you thought out in detail what might be done with such a steamer if we had her?—I think we could keep her employed regularly in the scientific work.

1773. Have you thought what her daily work would be; have you laid down any trawling stations?—I have fixed no stations.

1774. Do you think that one steamer would be sufficient for the east, the south and the west coasts of England?—She would do a very large amount of work—the more vessels the better—but what I meant was that a single good steamer would do more than what is done at present, and throw light upon a lot of problems which cannot be tackled. If two steamers were given more work could be done.

1775 What work should the steamer do?—It should carry out for example such work as is laid down in the International Conferences—that would be my general idea of the steamer's work for scientific work for fishery researches.

1776. Would you lay down certain stations over which she would trawl periodically, and take physical and biological observations periodically?—Yes, trawling would be only one branch of her work. She should engage in conducting fishery operations and collections.

1777. What information do you expect to get from trawling over particular grounds?—For example, if she trawled a well-chosen series of stations in the North Sea between the Dogger Bank and the Dutch or German coasts regularly throughout the year, we should undoubtedly obtain a knowledge of the migrations of the flat fish inhabiting that region; we should be able to say definitely whether there is or is not a connection between the plaice on the Dogger Bank and the plaice on the German-Dutch coast, and whether the small fish which so abound on the German-Dutch coast are a supply for the large plaice which are more generally distributed over the North Sea.

1778 You would not propose to ascertain from her trawlings whether or not the fish were increasing or diminishing?—Not solely. She would doubtless contribute to that, but without other work she would be quite inadequate for that purpose.

1779. Would she contribute to that problem?—Yes, in an indirect way by showing the connection between the fish population of one place and another.

1780. With regard to bottom work, would she be engaged on dredging operations?—Yes, doubtless, as to whether there was any difference in the richness of these feeding grounds.

1781. You have made some marine biological observations on this point?—Yes, in the Channel.

1782. Between which points was that work carried out?—Between Start Point and the Eddystone, and from the Eddystone to Plymouth, or a little west of Plymouth.

1783. That is quite a small area?—It is quite a small area, but on the other hand it was done very systematically, and the results are largely—the principle that is to be got by the exhaustive study of a small area can be regarded as a basis of conclusions to be applied to other regions.

1784. Do you think that the conclusions which you draw from those dredging operations will give you facts over a large area, such as that in the North Sea?—Not the facts, but they will give us certain principles which can then be tested with regard to the North Sea. For example, we find as the result of the trawling experiments off the Eddystone that the character of the ground, the nature of the gravel or sand is a very dominant factor in causing the distribution of animals there. We find this in a manner far more precise than was suspected before, and these results have given a definite character to that conclusion which we feel sure must regulate the distribution of bottom animals in other parts of the sea. Of course, the precise nature would not be applicable—the nature of the grounds would be quite different; but that general principle would be confirmed by further researches.

1785. In order to apply that general principle would not you have to ascertain the nature of the ground all over the North Sea?—Yes, for nearly all the purposes.

1786. Would not that take a very long time?—To some extent a preliminary survey has been already made by the Germans in the seventies. They spent a whole summer in the "Pomerania," which took a complete line all round the North Sea, and laid down the basis of the future classification of the ground, but, of course, that would want supplementing.

1787. Did you not find in the area which you investigated in Plymouth Sound that there were 18 different

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descriptions of ground within a distance of about 25 miles?—I daresay it is correct—I do not remember the numbers.

1788. Does not that convey the idea that you will have to survey the North Sea very closely in order to ascertain the differences in the ground there?—No; I do not think it does, for this reason: The region of our investigations was close to the shore, in a region largely affected by the tidal currents of the Sound and neighbouring estuaries, and from the rocky character of the coast the grounds are necessarily of an uneven character, and local differences in the bottom were to be expected on a far greater scale than in the open sea. In the middle of the North Sea I have no doubt for a hundred miles in succession the ground scarcely varies. I will not be precise about the actual number of miles, but that result is shown by the "Pomerania" expedition. The further away from the shore and the larger the area, the more uniform the bottom—that is a result already established.

1789. You will have to go over the ground to see whether that is so or not, will you not?—Undoubtedly, you will have to take certain well-chosen lines to come to a fairly satisfactory conclusion.

1790. Your steamer would also carry out physical observations?—Yes.

1791. Have you any data as to how far the observations taken at one point represent the conditions of neighbouring places?—There are materials available for conclusions undoubtedly, even in the North Sea in the results of the "Pomerania" cruises. The temperature of the whole southern region south of the Dogger Bank is remarkably uniform over a distance of 300 or 400 miles.

1792. That is in the southern part of the North Sea?—Yes.

1793. Did they take a number of observations?—Oh, yes, a great number of observations. Of course, the cruise was of a preliminary character, and no one would base practical conclusions on such an expedition, but they are the kind of thing that I should expect the English vessels to undertake until the whole of the laws of the movements of the food fishes and the effects on the fish population have been determined.

1794. You would also take plankton observations, would you not?—Yes, I attach considerable importance to them.

1795. Would you consider that samples taken at a few places would show the condition of the sea over the whole area?—I can state roughly what I mean. For example, I have been across the Atlantic twice in an ordinary passenger steamer and made continuous plankton observations across there from Liverpool to Montreal and from Philadelphia to Queenstown; and close to shore the plankton changes in character rapidly within, say—especially in the first ten miles, and then slowly for the next 100 miles; and then away from shore the plankton is extremely uniform for a thousand miles. It depends entirely upon the particular region investigated whether the plankton sample is a test of the character for five miles or five hundred miles.

1796. But I suppose in the Atlantic the depths will be great?—Yes.

1797. Whereas the North Sea is comparatively shallow?—Yes.

1798. Would not you expect a greater difference in the North Sea than in the Atlantic?—A much greater difference in different parts of the North Sea.

1799. South of a line drawn from Grimsby to Helsingfors is mostly in 30 fathoms?—Yes.

1800. And where you have 30 fathoms of water practically the whole body of the water moves with the tide?—Yes.

1801. Would not that create greater difference?—I do not think so. It is remarkably uniform away from the shore.

1802. There have been some investigations conducted in Germany with regard to that, have there not?—Yes.

1803. Do you know at all what they brought out—there were great differences, were there not?—They have not published any details of the plankton results; they have not worked them up in sufficient detail.

1804. Do you know the Ingolf expedition?—Yes, but I have not referred to that

1805. (*Mr. Spring-Rice.*) In the first place, I should like to ask you on that part of the memorandum which was not referred to by the Chairman. You think that the local authorities in one form or another can contribute to fishery research more than they do now?—Yes, I think so.

1806. By local authorities you mean in England the fishery committees?—I was speaking more or less generally. I mean, of course, the County Council committees.

1807. You know they are not necessarily for one county but for areas?—The only local authorities which carry out anything of that kind are the Technical Education Committees of the County Councils and the Sea Fishery Committees, but the district committees really have no powers in that matter.

1808. They have no power to spend money; that is the difficulty, is it not?—As a matter of fact, the Devon Committee by arrangement with ourselves is carrying out such work, but that is an exceptional thing.

1809. Then they are paying for it?—We pay a large part of the expenses.

1810. They are contributing?—Yes.

1811. It is rather important to know what you contemplate. Do you contemplate that the sea fisheries committees should be given more power and more funds with a view to making researches?—The idea in my mind is the result of watching the work of several local committees which are engaged in this work; for example, Cornwall and Lancashire Sea Fisheries Committees. The Lancashire Sea Fisheries Committee have carried out investigations more in relation to the drafting of bye-laws as I understand, whereas the Cornish authorities have carried out work of a different character, tending to the development of the culture of sea fishes, that is to say, of oyster culture and lobster culture, and they have been hampered to a large extent in Cornwall by lack of funds, which has prevented them from having a proper local staff to carry out the work. And in poor districts they cannot levy a large enough rate for such purposes. Fish culture the local authorities would be able to deal with in a more efficient manner than perhaps headquarters which would dictate rules.

1812. Would you say that the result of an attempt at fish culture—let us say in Cornwall—would be generally instructive?—I think so.

1813. To everybody contemplating fish culture?—Yes. I think there is an immense future before it, and more experiments should be made on a larger scale. That should not be allowed no doubt all over the country, but if a local body has definitely started and systematically pursued such a thing in that direction it would tend to the development of fisheries generally, so that a committee, or those who have shown equal zeal, should be assisted to such an extent as is possible in their work because it would be an object-lesson for the whole country.

1814. We all know that the Lancashire Committee, with the valuable assistance of Professor Herdmann, has done a considerable amount of work of this nature, has it not?—They have done there a large amount of scientific investigation, but not in the direction of fish culture such as I contemplate.

1815. That is done, I presume, because they think it more important to survey their seas than to attempt to breed fish?—Yes.

1816. So that they are working independently in a different line from the Devon and Cornwall people; at the same time they are working both for their own benefit, and for the general edification of the country?—Yes. They know their own needs better than outsiders, and they are adapting their knowledge to their local requirements.

1817. Do you think that might be extended?—Subject to a general control which would prevent needless extravagance, I think that kind of local inquiry would be of assistance to a scientific investigation of the sea.

1818. You think that some money might be handed out of the technical instruction fund for this purpose?—Whether that is possible or not, I do not know.

1819. You think it desirable, do you not?—I think that the work of instruction and research should as far as possible go hand in hand. Instruction then becomes of a practical character, and the researches rendered clear and precise and definite by the necessity of something positive to teach; and therefore if the two can be worked together there is no reason why the technical education should not be handed over to the same authority as the authority for research.

1820. In Lancashire the Technical Instruction Committee has applied some money for instructing fishermen?—Yes.

1821. Not merely in the mode of catching fish, but scientific information about the habits of the fish?—Yes. I hear that they have founded scholarships and that sort of thing.

1822. You believe in that sort of thing, do you not?—Well, I am rather sceptical. On the other hand, it is very experimental, and no one knows precisely in what direction the teaching of how to catch fish is successful or not. But I think on the whole the fisherman could be taught if he was taken young enough to adopt less wasteful methods. At present he is perfectly regardless of the question of the supply of the fish, and merely catches the fish as fast as he can. I think if the boys were taken in local institutes or fishery schools and taught the general life-history of fishes, of the connection between the spawning fishes and the growth of the ultimate supply, I daresay that would ultimately tend to make them more receptive of advice to adopt less wasteful systems of fishing.

1823. But to turn to your answers to the chairman, you spoke of scientific departments and scientific joint committees. What do you mean by that? Do you call the Scottish Fishery Board a scientific department?—But they have a scientific department, and I was referring to that.

1824. They have a scientific officer, among other officers?—Of course I do not know anything at first hand about the Scottish Fishery Board, but I judge from their reports being issued in three parts. The scientific investigations are included in a separate volume, and in charge of one individual, and they have a laboratory, I understand, for carrying out the researches, so I presume. That is what I mean by their scientific department.

1825. A branch of a department which is not scientific primarily, but which has all the duties of the fishery in its charge?—In my summary when I used the word scientific department, I meant to refer to the scientific section of a joint scientific and administrative board. I thought the question was purely one of organising scientific researches, and, therefore, I entirely left out the questions of general administration.

1826. Supposing the system of three fishery authorities of the three kingdoms were kept up, and that the scientific side of the work was strengthened, would you or would you not advise a continuance of the present Scottish Fishery Department in much its present shape?—That is a matter which would depend upon an intimate knowledge of the way in which the Scottish Fishery Department is worked, and I can lay no claim to that. On the other hand, it is the sole and only object lesson we have, and therefore it might give a result. Judging from the published results there are certain disadvantages in having the scientific body too intimately connected with the administrative board, and if I may be allowed to do so, I would mention an instance, I would give the Moray Firth. I may be wrong, but I have been informed that the closure of the Moray Firth is really not a question of scientific investigation, but was adopted in order to pacify a certain class of fishermen—to keep the peace between two rival classes of fishermen. On the other hand, it is generally believed, and it has been said, that the Moray Firth is closed for the purpose of scientific investigation. Between those two statements there is a distinct divergence, and I don't think that it is good for science that it should be possible for scientific researches to be made the excuse for administrative changes. If you could avoid that risk by separating the scientific department from the administrative, then I should recommend such a divergence—such a change, but, as I say, the question involves a knowledge of the details which I do not possess.

1827. What do you say about the museum? Would you describe the sort of museum that you contemplate, because you first spoke of an exhibition of the natural products of the British seas, which would be a very suitable appendage to the British Museum Natural History department, and then you spoke of an exhibit of normal sized fishes?—That is so—given as a matter of very slight illustration. It is one that first came to my mind. I have not really thought of it. If you have for England a scientific department, and if they have relations with the administrative department or board or whatever it is, it would be necessary for them to have headquarters in London; that is to say, they ought to have a laboratory, and although the chief function of a laboratory is to provide a working place and materials in which to carry out investigations, there is always the question of storage. If you are to have two ships collecting material over the British seas, that material is of great value. It wants storing up for reference, and although I only mentioned the flat fishes in connection with legislation, yet undoubtedly in regard to this fishery museum one of its functions would be the taking care of the vast collections made by those ships.

1828. Is there much in the museum beyond what the British Museum might properly do by having a special collection of British marine biology?—Really the British Museum might do the show part of the work without any change. I do not question that. But, on the other hand, if there is to be a set of scientific men working solely at fishery problems, they ought to have the material which they have collected by their ships under their own control for future purposes. The value of collections of fishes is very great when the collection is complete, and the work and the result of one year's survey is not completed in the next year: it often has to be prolonged over five or ten years, and often enough material is collected in one year that has to be stored up for future years. Therefore the fisheries museum would be the proper place where all these stores of research material should be collected, not necessarily for display—the display would be a minor part of it.

1829. This laboratory and museum or store place is very much what has been attempted to be supplied at Plymouth, is it not?—At Plymouth we have no place for such large collections.

1830. It might be a question of making it bigger, but that is the same kind of institution, is it not?—Yes, it could be stored in the laboratory. As far as that part is concerned it could be done at Plymouth certainly, or in any other laboratory. In connection with that matter I was thinking that the work of an English scientific department would involve a large area, part of which would be the North Sea, and, of course, the western region; and for a boat, if only a single boat, doing the two regions, it would be convenient for many purposes to land the North Sea specimens in London or some neighbouring point. Then those specimens would be accumulated in the London headquarters.

1831. For the North Sea would not Grimsby be a better place than London?—Grimsby or Lowestoft. I do not attach absolute value to those things put in here about London being the headquarters of such a store. If you have a local depôt, which I also suggested, on the coast, undoubtedly you could make that a store place for the fishes. On the other hand, you would then have to enlarge the idea of a local depôt, and make it more of a laboratory. If you have a laboratory on the coast then you can store the material, and have the work done there. But if you have only a place where the steamer could land its stores, at Yarmouth or somewhere else, then you must have another laboratory in London; it need not be a large place, but there must be something of that kind.

1832. But for purposes of central administration in the sense of being in touch with the actual trade, Grimsby or somewhere else there would be infinitely more convenient than London?—I think so.

1833. Because there is no fishing strictly speaking at London?—Undoubtedly the closer to the fishing centres the better for scientific work.

1834. Mr. Archer put to you some questions about schemes of investigation in the North Sea. I gathered what you mean about the Survey is that though you could not get an absolute survey in a large area without immense expense of time and money, yet the probabilities are that a rough survey of the North Sea would be of practical value?—Undoubtedly.

1835. I do not mean a very rough one done in one summer, like the German ship that you mentioned, but if one ship devoted its time to that for four or five years, in addition to the information got from the Admiralty charts, and so on, would not that give material for a working system for obtaining a knowledge of the North Sea?—I think so, in this way—to mention a case in point. At the Select Committee on the Sea Fisheries Bill a year or two ago there was a great deal of doubt as to the extent to which large and small fish—plaice, I think, was the fish principally mentioned—are mixed up on the grounds; whether the small fish was on one set of grounds and the large fish on the others. I have not the least doubt that a single ship could settle that question

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hy exploring over the ground in question, and therefore the knowledge so obtained when properly sifted and reported upon would be evidence beyond cavil, and it could be used as a basis for legislative proposals on such subjects. Therefore one could fitly claim it to be of a useful character.

1836. It would be evidence on which prudent men or a reasonable legislature might act?—I think so.

1837. But it would not be complete?—It would be far more complete if the British vessels would co-operate with other nationalities in a more extensive scheme, but even by this means England could do something positive and useful, but the results would be far greater by the co-operation of other nationalities.

1838. Supposing you were trying to find out the distribution of large and small plaice, as you were connected with the Christiania Conference, could you say whether this question was put generally or was any definite problem put at the Christiania or Stockholm Conference on which they were to seek an answer?—I had nothing to do with the Stockholm Conference.

1839. Is the Christiania scheme an answer to any definite question, and if so what question?—I think several. It provides the means of settling those questions.

1840. Several questions?—Yes. The Scandinavian question as to the cause of the fluctuations of their fisheries, for instance.

1841. That is mostly cod and herring?—That is mostly cod and herring, and to a slight extent mackerel, but chiefly cod and herring. These fisheries have been subjected to very great variations, and it is a matter of great importance; but the advantage is largely, to a maritime population, in knowing whether those fluctuations can be avoided or not, and if not whether any rule can be assigned to the movements of the fishes And the scheme of the hydrographic and plankton work to my mind is so complete as to lay the foundations for an answer to that problem. Then there was a question as to flat fishes. I think there is no doubt if the trawling experiments which are detailed there are carried out in the southern part of the North Sea, more especially by the co-operation of German, Dutch, and British vessels, and to some extent Belgian vessels, the result would be to throw a very different light upon the movements of the flat fish in that region, the distribution of the large and small fish, and therefore to provide an exceedingly good basis for any legislative proposals or to decide whether any legislative proposals are necessary or not. It may even result in showing that no legislation is advisable.

1842. Of course, the question of the flat fish is the one in which Great Britain is concerned primarily, is it not?—Certainly, to a great extent.

1843. That is practically the only important question for us?—I would not say the only one, but it is far and away the most pressing question.

1844. Then the biological part of the Christiania scheme is well designed for our purposes?—Yes, I have not the least hesitation in saying so.

1845 And the hydrographic part is more for the benefit of the Norwegian people?—I do not mean that; although I used the word hydrographic in connection with the Scandinavian researches, yet it is absolutely essential for the trawling researches, and for this reason that some of the Continental delegates are not convinced that the apparent diminution of the supply of flat fish is due to over-fishing, but perhaps due to hydrographical causes—that is to say, to the currents of water which supply that part of the North Sea. I remember one member, Dr. Hoek, the Dutch delegate, who is now Director of the Central Bureau, told me that he was strongly of opinion that the recent changes in the supply of soles in the southern part of the North Sea had been very largely affected by recent changes in the weather, which had also affected the water covering their grounds. They live in very shallow water, and therefore they are subject to fluctuations of weather; for instance, in severe winters the Silver Pits used to be full of soles, and they go into as deep water in winter as they can get, where the water is warmer. All soles accumulate in deeper waters from all quarters. That shows the direct effect of metsorological or hydrographic conditions.

1846. So that hydrographical information is of importance to Great Britain?—It is almost of as much importance to the solution of this trawling question as to the solution of the herring and cod question.

1847. Does it not come to this, that if you were asked to advise on a scheme designed to deal with the problems connected with trawl fishing in the North Sea and north of the North Sea you would advise a scheme rather like the Christiania Conference?—I might not have been able to advise it offhand in the first place, but after seeing the scheme and hearing all the arguments in favour of the particular portions of it I should certainly approve of it and corroborate and adopt it.

1848. You were concerned in recommending it, but would you still recommend it from the point of view of Great Britain?—Undoubtedly, I have not the slightest hesitation in doing so.

1849. Apart from that big North Sea problem, supposing there was an English, Irish, and Scotch Fishery Committee, and supposing the Lancashire Committee had a scheme on a similar scale, would your idea be to have someone in the centre to propound problems to each of those bodies and get them each to work out its own problem for the information of the whole?—If there were no international proposals before the country (which I think offer the best programme that could be put before the country) then there should be undoubtedly some means of ensuring that the vessels of Scotland, Ireland, and other vessels should co-operate in regard to the larger problems of the sea. On the other hand, I think it is on the whole wise to leave them locally to determine which are the problems of local importance. I have thought a good deal over this point. The difficulty is that local bodies are apt, of course, to attach the greatest importance to their local problems, and unless there is some co-ordinating mechanism they may forget and overlook the general problems which would really throw light upon their local problems indirectly, and be the best way of settling those local problems.

1850. As an instance, we all know that the mackerel is the great Irish fish, and the herring is the great Scotch fish. If there was a common fund available for investigation would you, or would you not, think that it was reasonable to say that the problems about the mackerel (except quite trifling things) should be dealt with by the Irish Board, that problems about the herring should be undertaken by the Scotch Department, and each learn from the other?—I think it would be a mistake. With regard to these two fishes, you know that they are migratory fishes, and the problems of migrations would be better dealt with by a joint investigation in regard to both herring and mackerel, and it would probably throw more light on each question than by separate inquiries.

1851. That is another point. May I take some other instance, shall we say the haddock for Scotland—a fish quite different from the mackerel and the herring. Would it do right or not for a central authority to say to the Irish department, "now do not meddle with the haddock, the Scotch Department will deal with that", and to the Scotch Department to say, "do not meddle with the mackerel, the Irish Department will investigate him"?—Except in cases where there would be no need for instruction—as where the fish is the dominant fish—it would be a great mistake.

1852. You would allow them to duplicate?—I would not allow them to do the same work, but I would make them so design their fishing and scientific experiments as to lead to the solution of both problems. You might, for example, in the case of the mackerel, which is found round the North of Scotland, and so forth, and although dominantly an Irish fish, yet it does occur in Scotch waters, unless you design your experiments to cover the whole region, you may leave out an essential factor if you say to the Irish Department, "You shall alone inquire"; they could not cover the whole region, and would thereby leave out some parts of the inquiry which would throw important light on it.

1853. If the funds available are limited would it not be better to let each of the three departments (if there were three) take up special subjects of more pressing importance to them?—Yes, it certainly would. I have provided in my suggestions for that by leaving the local scientific departments, that is to say the Scotch, Irish and English departments, to decide which are of local importance, but in addition to have some co-ordinating mechanism by which three bodies or two of the bodies shall combine to settle problems which affect both. There are many such problems, and I would leave the three bodies separate to deal with them.

1854. There is great danger in the one case of duplicating, and in the other of wasting the power if there

are three independent bodies, is there not?—I think some measure of importance should be attached to having independent bodies; but on the other hand, some means of co-ordinating is necessary for the general problems. I was very uncertain as to which is the proper solution. If you leave the three bodies separate they will neglect the general problems, and if you appoint a Director-General, as in the Geological Survey, directing from an armchair, he might neglect the local problems. I thought it would be better for the superintendents of the three kingdoms to draw up their own schemes and meet regularly to see to what extent they could combine their investigations for the solution of general problems. In order to have them to carry out the work impartially and effectually they ought to have a competent chairman to ensure proper consideration, and to come to correct conclusions. I thought that would be a more elastic method, and would offer one more proper safeguard for the carrying out both of general and local problems than either absolute independence or absolute dictatorship. I think some measure of freedom is essential for science. Unless you are free to criticise your colleagues' work you become unscientific.

1855. (*Chairman.*) I would like to ask you how long have you been at your present work?—As regards sea work, I have been investigating the natural history of the sea since I took my degree at Oxford in 1888, that is to say about 13 or 14 years, but I have been specially devoting myself to fishery questions since 1897, that is to say five years.

1856. You have spoken of fish culture as one of the means of developing fisheries, which has not yet received a fair trial in this country?—Well, many trials have been made, but of an unsuccessful character.

1857. By fair I mean an adequate trial?—I do not think they have. But it is less the adequacy; it appears to me to be a new branch which if properly looked after may be of great importance in the future—it has been a neglected branch. People have not devoted their attention to the cultivation of sea fishes as a possible means of making a new industry. I fancy that when we have solved certain problems dealing with the rearing of the larvæ—the young fry of the sea fishes—that a new industry may be created which may make valuable progress in many in-shore localities.

1858. The Marine Biological Association has not undertaken that?—It has undertaken the laboratory experiments, how to grow up the fry from the egg.

1859. But it has not undertaken hatchery experiments on a large scale?—No, on this question I do not attach so much importance to hatchery. The hatching of sea fishes is a problem already solved, but what I mean is rearing the hatched fry up to a point when they are beyond the dangers of a floating life.

1860. That is what I meant by hatchery experiments?—Of course the ordinary hatchery is putting the eggs in tanks, and taking the fry into the sea. As far as the utility of that is concerned, it is absolutely useless. No case has been made out in any country. On the other hand, I will not say that it will not be useful in the future. But I mean rather the development of the art of cultivating fishes as you cultivate cows, keeping them in an enclosure and under control. The young fry of many sea fishes can be put into ponds and fed regularly, and kept in a sort of tame condition, and I believe that some valuable fishes treated in this way would become a valuable form of industry. But there are certain difficulties which are not overcome, and which I would like proper attention drawn to by scientific people. It is being attended to by some people, but it ought to be kept in mind.

1861. You mean a kind of marine poultry yard for the fishes to be grown to maturity for the market?—Yes.

1862. Without being liberated at all?—That is my idea; that should be a thing to aim at certainly.

1863. Have you seen the Logan fish pond?—No.

1864. Where fish are brought in and fed?—I have read of it: I think it is the one referred to by Bertram in the "Harvest of the Sea." I have not seen it. My idea is not bringing them in from the sea but hatching the eggs in an establishment on shore, and turning the fry out in such a way that they should avoid their enemies. It would not be a practical measure for most fishes, but for some fishes, and I hope to live to see the day when this will be realised.

1865. We are to understand, when you talk of fish culture, you do not mean to express that you are sanguine of the results of any attempt to replenish the ocean by artificial means?—I maintain an absolutely open mind on that question. The sea is so vast, and unless the work is done on a colossal scale—which would mean a colossal expense—I do not see how you could materially affect the population of the sea by such measures. On the other hand, it remains to be proved whether the alleged impoverishment of the sea is due to the destruction of spawning fishes. If it is true that the number of fishes in the sea is becoming less year by year in certain species (and there seems evidence for it), then it would appear to show that there is an over-destruction of the eggs of fishes, and it is then a question of inquiry whether you can by artificial methods put into the sea a sufficient number of eggs to compensate. I do not think it is possible by that method, which is advocated by some, of having a few fish hatcheries, because they cannot deal with anything like the proper numbers. The biggest fish hatchery which has been ever constructed has never turned into the sea more than 400,000,000 eggs in one year.

1866. 400,000,000 fry?—400,000,000 fry, which is much the same thing, in my opinion; but the number is so small compared with the total number of fry in the sea, that it seems to me ridiculous to expect any result as regards the general population of the sea. But I still have a weakness for Mr. Fryer's suggestion that if we can get the fishermen all round the coast to fertilise the eggs of fishes in the ordinary course of fishing operations, by that means you could deal with the question on a sufficiently large scale. It seems to me that there is hope for that.

1867. The ova of most fish do not ripen simultaneously?—No.

1868. Only a small portion of the ova would be ready for fertilisation at the same time?—Yes, but still it is a very appreciable portion; it is a very large proportion in the case of many species.

1869. Take plaice, for instance. Say that the ova of plaice weigh a couple of ounces, and a proportion of that would be ready for fertilisation at a given moment; have you made any calculation?—It has been done slightly, but not on a nearly sufficient scale. The Christiania programme provides for work on that particular point for more exact information to be obtained on that question.

1870. You cannot indicate what portion of this plaice would be fit for fertilisation at the moment?—Not by weight.

1871. But that is an important factor in what you have recommended—that we should encourage the fertilisation of eggs?—I do not say that, but I believe it is worth inquiring into on a scientific footing whether such a problem can be solved.

1872. You do not go further than that?—No, it is a matter for urgent inquiry whether the number of fish that can be dealt with in that way every year would be sufficient to enable the fishermen to put back into the sea a sufficient number of eggs—not to do it at once, but to inquire as to how many eggs could be put back into the sea.

1873. Are you familiar with the American returns?—Yes.

1874. It is claimed, is it not, that a considerable measure of success has attended artificial hatcheries in that country, both in salt and fresh water?—Yes, it has been claimed.

1875. Do you entertain any doubt as to the accuracy of the returns?—There can be no doubt of their success in dealing with fresh water fishes. They have undoubtedly made a brilliant success of their shad action.

1876. You mean transplanting shad from the Atlantic to the Pacific?—Chiefly that. I have not looked sufficiently closely into the work of merely working the hatchery and putting fry into different rivers, but the actual transplantation is a great success. But with regard to sea work there is not a shadow of evidence that their work has been effective.

1877. Even in regard to lobsters?—No. I am speaking of fishes—of the cod, for instance—not as to the lobsters. They did claim to have materially increased the quantity of their cod, and they called it the Fish Commission cod. I looked into that evidence very carefully some time ago, and I have talked with some of the American people themselves, but their published evidence is sufficient to condemn them, and I have looked into it care-

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fully. I do not think there is any satisfactory evidence that the increase of cod was due to their hatching operations, but rather to natural causes.

1878. (*Mr. Archer.*) With regard to shad, that is rather a different problem: that is the introduction of fish where they did not previously exist, not the increase of the existing supply?—I believe it is simply transplanting, but there is no satisfactory evidence of actual benefit resulting from pure hatchery operations except when coupled with transplanting. But the attempt to increase the stock of fish in any locality where it already exists by artificial measures has not in my opinion been shown to be even reasonably probable.

1879. (*Chairman.*) There is, is there not, the initial advantage that a much larger percentage of eggs can be ensured for fertilisation by artificial means?—It is claimed, of course, by Americans and others that that is the great benefit.

1880. But is not that the case?—I have looked into the evidence, and I have not found a scrap of it. What is the normal percentage of eggs fertilised at sea? No one that I know knows what is the normal percentage, and no one has discovered unfertilised eggs in the sea, which is one of the factors one would expect them to find out; and so far as sea fishes are concerned there are not very adequate figures in regard to the number of eggs which can be artificially fertilised. But the Scottish Fishery Board have been very successful in showing that 90 per cent. of the eggs can be artificially fertilised. This statement is a rough one, based on the experiments of Mr. Harald Dannevig with plaice in the pond at the Dunbar hatchery, where it has been found that at the beginning of the spawning season a good deal of irregular spawning takes place, the eggs remaining unfertilised (13th Report of the Fishery Board for Scotland, p. 126). Exact figures are not at present available as to the number of eggs so wasted, owing to unnatural conditions in the hatchery, though in the 12th Report (on the first year's work) the loss due to non-fertilisation was estimated at less than 0·1 per cent. for the whole season (L.C., p. 212). It is clear, however, that the methods adopted in fish hatcheries have no advantage as regards efficient fertilisation over the method of artificial spawning on board fishing vessels. Dannevig mentions a batch of half-a-million cod eggs which were fertilised on board a trawler, all of which were fertilised (12th Report Fishery Board for Scotland, pp. 212, 216).

1881. But you say there is nothing to show that the rate in the sea is lower?—I cannot find out; it may exist; I have asked people, and they can show me no evidence upon the point, and until we know that we cannot lay claim to hatching as a benefit.

EIGHTH DAY.

Wednesday, 22nd January, 1902.

PRESENT:

The Right Hon. Sir HERBERT MAXWELL, Bart., M.P. (*Chairman*).

WALTER E. ARCHER, Esq. | STEPHEN E. SPRING-RICE, Esq., C.B.

R. E. MARTYR, Esq., *Secretary*.

Mr. WALTER E. ARCHER (a Member of the Committee), recalled; and further Examined.

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1882. (*Chairman.*) I think you wish to add to the evidence you gave on a former occasion?—Yes. I seem to have misunderstood the purport of Questions 1590 to 1593, which were put to me by Mr. Spring-Rice. In answer to the last, I said: "If I understand your question to mean whether I have drawn up a scheme of laboratory research, I must answer no. I do not think we are at present sufficiently far enough advanced for it to be worth while for me to formulate such a scheme." That answer, taken together with the first part of Question 1592, might be understood to mean that I had formulated no scheme of scientific research, nor as a matter of fact have had occasion to ask for the assistance of specialists to enable me to work out answers to the problems which have come before me. In fact I have since had reason to believe that my answer had been misunderstood. I should like, therefore, to be allowed to explain very briefly what I had in mind in answering this question, and to state what I have done. What I had in mind in answering the question was that since I have held my present appointment I have not drawn up in consultation with specialists any detailed scheme of purely laboratory research, such for instance as the scheme of purely physiological investigations which I drew up in consultation with Dr. Noel Paton, when Inspector of Salmon Fisheries in Scotland. What I have done has been chiefly in the direction of seeing how the raw material for the purpose of these investigations can best be collected. It is obvious that no investigations of any sort can be carried out until arrangements have been perfected for obtaining the raw material.

1883. The raw material being what?—The actual fish and other products caught either by commercial trawlers or by a special boat. It was recognised at the Stockholm Conference that this was the crux of the whole matter, although it was a question on which there was great divergence of opinion; and it seems to me that it can hardly be denied that the want of success which has hitherto attended some of these investigations is due to the fact that sufficient consideration has not been given to this question. With regard to sea fisheries therefore it is to the method of collecting such material that I have chiefly directed my attention. As I pointed out in my evidence there seemed to be three methods by which it was generally considered that this material could be collected. With a view of throwing light on the first method, namely, the capability of a special steamer for such work, I applied for and was granted the assistance of two statistical assistants to analyse the "Garland" experiments. The results I have put before you. The second method, for the reasons I have given in answer to Question 1577 did not commend itself to me, but with a view of testing the third, namely, how far it was practicable to obtain such material from commercial trawlers, I applied for assistance in the collection of material from steam carriers landing their fish at Billingsgate. The problems which it was proposed to study by this means are those mentioned in answer to Question 1585. Some are purely biological, others statistical, but all are of high scientific value if thoroughly and accurately carried out. My request, however, was refused solely on the ground that no funds were available for the purpose. In the absence of funds to obtain even the raw material it was useless attempting to place myself in communication with specialists to carry out the purely biological investigations or to proceed further in the matter. With regard to salmon, I furnished the late Sir Courteney Boyle with a scheme of scientific work, showing the object of the investigations proposed and the detailed method of carrying them out. This scheme involved the assistance of biologists in different branches of that science. My colleagues and I also in our last annual report invited the co-operation of boards of conservators in a general effort to collect regular information on a uniform basis, which, although not necessarily requiring the employment of specially trained workers, would be of great scientific value if it could be obtained. Lastly, in the absence of means to personally carry out or direct such work, my colleagues and I have made suggestions for the investigation of particular problems which have subsequently been carried out by others. I may say, therefore, that so far from not recognising the importance of

such work, to mention one point only, there is hardly a bye-law comes before me which does not involve some fishery problem requiring accurate and methodical investigation, and unless some arrangements can be made for the solution of such problems, I cannot properly discharge the duties which are placed upon me.

1884. (*Mr. Spring-Rice.*) I only wanted to get out from you as chief inspector what your course of procedure had been, and the statement you have now made gives that information very clearly. As a matter of fact, it came to this, that in sea fishery matters you, for good reasons, came to the conclusion that you had not got to the point in which you wanted to call in a scientific man, that is to say, a biologist?—Quite so.

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1885. That is, not a reasonably trained person, but a specialist, and that is what I wanted to bring out?—Quite so.

Mr. G. L. Alward, called; and Examined.

1886. (*Chairman.*) You are a trawl owner at Grimsby, a fishery member of the North Eastern Local Fisheries Committee, and also a member of the Town Council of Grimsby?—That is so.

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1887. Have you formed any views as to what can be done towards the assistance of an increase of knowledge of our fisheries?—Yes, I have always contended that the Government should take up some means of research of the sea so as to be able to confirm many of the observations which have been made from time to time by our fisheries people.

1888. How do you propose to set about that—it must be something systematic, must it not?—It must be systematic. Of course if it was a question only of ascertaining whether there was less fish in the seas around the United Kingdom, by collecting statistics pure and simple from the vessels which land the fish, you would be afforded that information. Then if it was a question of ascertaining whether there was a diminution of any particular kind of fish, that also could be obtained from that source, but the variation of the quantities of any particular kind of fish from year to year must be obtained by scientific investigations quietly and persistently carried on.

1889. I am not quite sure that I follow you in the difference that you draw between the scarcity of fish generally and the scarcity of a particular species?—There is each year a difference in quantities of the various kinds of fish, and that is on the same particular grounds; for instance, you will find a scarcity of haddock on a particular fishing ground, and perhaps a rather more plentiful supply of some other kinds of fish.

1890. That would be obtained from the returns of the fishermen?—Yes.

1891. Would you mean that the causes would be the subject of scientific investigation?—Yes.

1892. Mr. Holt and Mr. Cunningham did work at Grimsby for a couple of years, did they not?—Yes, they did, and collected very valuable information. I think a great deal of Mr. Holt's and Mr. Cunningham's—more particularly Mr. Holt's investigation, which was to ascertain the size to which the flat fish attained before it could be considered sufficiently developed to be able to reproduce its species, or to ascertain what may be considered immature fish. I think that was one of their particular investigations.

1893. Are you speaking of the fish or the ova?—I am speaking of the fish before it produces the ova in order to propogate—of course the fish must increase in size before it could be found with the ova in it.

1894. Did they adopt this system of circulating a form of questions among fishermen?—No, I do not think they ever did.

1895. Would it be any use attempting anything of that kind?—I think so. You might get some useful information in that way.

1896. Are fishermen always willing to give it?—No, not as a whole, but you will find men who take an interest in what we may term scientific questions relative to fish, and you would find a number of these people who would be willing to do so. There is a certain amount of jealousy, I admit, on the part of both the owner and the fishermen, but I think when it was explained and you got hold of these men who take an interest in such matters that the unwillingness would vanish, and you would get valuable information from the fishermen.

1897. Do you think you would be able to collect reliable statistics as to the temperature of the sea, for instance?—Yes, I think you would be able to find some of our fishermen who would be willing to do that.

1898. And the character of the bottom?—Well, of course, the character of the bottom is one of those things which is a part of a fisherman's calling; he is never supposed to have learnt his trade properly until he has fixed in his mind the character of the bottom and of the fishing grounds which he frequents. That is a *sine quâ non* in connection with his knowledge as a fisherman. Speaking now of trawlers more particularly, I think I may say myself that the experience I have had—though it is thirty years since I had any practical fishing other than what I have done in recent years on experimental voyages, but I think I may say the nature of the bottom of the portions of the North Sea which we frequented are just as well fixed in my mind as the colour of these chairs or of that wall, because it is a part of our make-up.

1899. And such questions as the temperature of currents—are fishermen generally sufficiently aware of the exact position of their vessel at any given time to make those returns of scientific value?—Yes, some men more than others, of course. But such persons as might be selected to make those returns would be men above the average—men who could be relied upon to know their exact position.

1900. I think you are in favour of the establishment of a central fish museum?—I consider that we are much behind other countries by not having up to the present followed up that.

1901. Have you visited such museums in other countries?—Well, I really cannot say that I have. I know of the collections in America from the intercourse that we have had with Captain Collins and several of their officials, and from the pamphlets and published matter of the institution in Washington. I know the elaborate system they have of collecting information and tabulating it, and to some of these museums I have contributed myself small matters and I have had in return their publications.

1902. Where would you have the museum?—It has been suggested that Grimsby, being a large fishing port, would be a very useful place, but my own personal opinion is that the means required to set up a suitable institution—a national institution—are such that I do not know of any place in the provinces that could undertake it unless the State would undertake the largest portion of the expenses. Some of our local friends are very anxious to have possession of the Buckland Museum, but I am afraid that they are not acquainted with the dilapidated condition that it is in, and the money that would be required to put it right.

1903. Was it ever right?—Well, it was certainly so in its early days, when I saw it twenty or twenty-five years ago. Then it was of very great public interest, and much of the collection was in a very good state.

1904. Would you have the museum connected with a central fishery department?—Well, I think that is a matter of detail. I have considered myself, as an Englishman, that with regard to our collections at South Kensington—the whole of those scientific collections—the proper thing would be to have them associated pretty closely one with the other.

1905. (*Mr. Spring-Rice.*) I am glad to see that you think that the skippers of trawlers can give valuable assistance in getting scientific information. Do you think that the trawling companies, if properly approached, would be willing to aid any disinterested authority in getting that sort of information?—Yes, I think so.

1906. I do not know whether you are aware that at Aberdeen, which is a large trawling port, the scientific officer of the Scottish Fishery Board is endeavouring to get information, at all events as regards the place where, speaking roughly, the different sorts of fish are taken on each trawler's voyage—have you heard of that?—I was not aware of that. You probably know it is a thing that I have recommended, and that it is the only way to collect information.

1907. But you are hopeful that some skippers at all

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events, or some companies, would give that sort of information to a disinterested party?—Yes, that is so. If the object in view was to collect knowledge from all vessels of the fish obtained in any particular part it would have to be collected from each ship, but if it is only for some particular branch of scientific information well, the difficulties would be less—you would find that you might select certain skippers who would be very glad to assist us.

1908. I am speaking in the first instance of the information that a fisherman would be interested in practically the place where he caught his fish, and the quantity and descriptions of the fish caught at that place?—There is a certain amount of reserve about those things, I must admit there is, and it would have to be approached in a proper manner—in an official manner—to get the information.

1909. Do you think it would make it easier to get the information if a pledge of secrecy were given as regards each individual catch?—That would have to be so—it would have to be looked upon as official information for official purposes only.

1910. Do you hope that it would be possible to make the people interested, to understand that it was only for that purpose, and that nothing would be published to hurt them individually?—I think that could be done.

1911. Knowing that what is done is for Government and scientific purposes, do you agree that that pledge could quite fairly be given?—I think it could by a judicious selection of the persons.

1912. It would be quite true that you would not want to publish anything to prejudice any individual, and do you think that when that pledge was given people would be disposed to help?—I believe so.

1913. Are you acquainted with the general scheme for the international exploration of the North Sea?—Yes, I have read very carefully through the programme.

1914. May I ask, do you generally approve of it?—I think I entirely approve of it—I think I may say entirely approve of it. I have one exception to that. I think England should have done a great deal of this herself. I think it is right that I should give my opinion upon this question. I think that we are now setting about to assist other nations, and enabling them to get information, which they will turn to a very large account, which we ought to have got for ourselves, and kept to ourselves. I am now speaking of the international programme—I have read very carefully the discussions, so far as they go, in the condensed report, and I say that England should have obtained that information, and kept it very largely to herself. I think I am justified in saying that it is the general opinion of many of our people connected with the fisheries, who take an interest in all these matters relating to the welfare of the fisheries, that there is a lack of information possessed by the Government. They think that the success of our fisheries has been so great that it has attracted the attention of the European Powers to it, that they are now going to get an advantage from our experience, and the method now adopted will be greatly to their advantage, and we ought to have done it ourselves, without any connection with them in any shape or form. That is the feeling of the fishery community.

1915. Supposing that a scheme is going to be undertaken of that nature would Grimsby be willing to give any assistance that they could?—I think that the assistance that they would give would be to our own Government. A fortnight ago I refused to take any part in giving information to an agent who came on behalf of the Norwegian Government. The Hull people I think feel jealous too. I think one man has undertaken to assist, but they think that we had better keep our information to ourselves, and so far as I am concerned I said to this Norwegian gentleman: "No; I am prepared to assist our own Government for our own purposes; it is not right for you to come here; there is going to be an international collection of this information, and we will do it, and when it is done you will have the right to it; you seem to be overlapping each other, and you had better stay at home."

1916. You think in the minds of people interested in fisheries at Grimsby and Hull there is clear distinction between trade information and what may be called Government information?—That is so, and it must be made very clear that it is Government information for scientific purposes.

1917. You know, of course, that an attempt is going to be made to get the fishery statistics of the fish landed at Grimsby on a better basis?—I am aware of that.

1918. You think in that attempt there should be friendly assistance from the trade?—There will be just the same friendly assistance as there has been, but there will be, I am sorry to say, an unreliable account equal to what it was before.

1919. I am sorry to hear you say that we won't get any better information than we did, because that was bad enough?—Well, there is not the slightest doubt of it unless you set up a proper system. I take an interest in these matters, and I speak with feeling that when you set about collecting statistics for the nation there ought to be no two opinions about the genuineness of them—they ought to be thorough. I now again refer to the American system, and I have no doubt you gentlemen have made yourselves perfectly acquainted with these things, they have a most elaborate system of getting information and statistics. From what Captain Collins, who is now, I believe, the head of the Fisheries Department in America, told me on the last occasion when he was with us in Grimsby, when we had a private conversation after he had given us a public exhibition, and an account of his fisheries I asked him, "Are those statistics correct; are they reliable?" He said "We have every reason to believe that they are thoroughly reliable." That is what I should like people to do, to be able to say that our Government statistics so far as our fisheries are concerned are thoroughly reliable. That has always been my object.

1920. It is to be hoped that the trade will co-operate in what the Board of Trade are now doing to get the Grimsby statistics reliable?—Of course you have been told of the difficulties—you know there are difficulties. I was only with Mr. Hood on Monday when he was collecting his information. As he gets it now he has to rely upon the captains, and if you take the captains as a whole there is a good deal of jealousy; and whilst he may have a great many of his captains whom he could go and speak to and get thoroughly reliable information from, there are a large number who are equivocating. He cannot follow it up, and he cannot see the fish those ships are landing and satisfy himself, for the things are too vast. Those who have visited the Grimsby pontoon will know that it is a desperate thing to collect statistics at a place extending over a mile.

1921. Let us hope that there will be an improvement?—They will do their best no doubt.

1922. That is rather beside the present purpose. Now I want your opinion upon one other point. There has been some talk on these questions of scientific work of fisheries of giving instruction to fishermen, not in the practical arts of navigation and trawling and so on, but in some more or less scientific information about the habits and the lives of the different sorts of fish—would you attach any value to that?—I attach a very great deal of value to that, and if the British Government will set up a central station with a staff of suitable persons, of whom we have a large number in this country, they would take hold of the fisheries and get useful information; they will get large assistance from the fisheries on the coast, and they will impart to our fishermen a large amount of useful information, the latter will return it if a close connection is kept up. I am certain that Mr. Holt and Mr. Cunningham have got an immense amount of information, and they imparted to our fishermen an immense amount of information. They created in the minds of many of the men a curiosity which led to investigation on their part, and gradually you will collect a very great deal of information in that way.

1923. Are you aware that the Lancashire County Council have spent some money in instructing Lancashire men in that way?—I am aware of that.

1924. Has your Lincolnshire County Council done anything in that direction?—The Lincolnshire County Council have not. But the Urban District Council of Cleethorpes (which is adjacent to Grimsby, but not within the borough) have done something. They have spent money to instruct the fishermen. A large portion of the Grimsby fishermen reside at Cleethorpes, as you know probably, and they are doing all that they can in that direction.

1925. Are the results satisfactory?—I could not really say what the results are.

1926. Do you think that the principle is right?—The principle is perfectly right.

1927. (*Mr. Archer.*) There is only one point I wish to

ask you about. Do I understand you that a fisherman in following his calling takes particular account of the nature of the bottom?—That is so.

1928. Now, as a matter of fact, do you find the different fish frequent different bottoms?—That is so.

1929. On what sort of bottoms are plaice found?—A stony—rough stony or small oozy—ground, and shelly ground. To follow this investigation the stomachs of the fish have to be examined We know that on the Dogger Bank there is a vast amount of small shells, in the spring of the year we found plaice there when they were in abundance, and now limited in number as they are, they are full of small shells—that is the kind of food they like

1930. Now, do you find that there are sudden and frequent changes between one description of bottom and another?—Oh, yes, in areas. So much so that, for instance, to go back to the time when we started exploring the North Sea, when it was hidden sea to us, the same as Africa was some years ago——

1931. (*Chairman.*) How long is that ago—about?—About 1820 or 1828, and so on, the area of the fishing grounds worked on the east coast was very limited indeed when they commenced trawling. The first thing that a trawler did was to drop his lead down with the grease upon it, the rough-and-ready method of getting to the bottom of the sea, and in those days we never attempted to shoot a trawl unless the ground was perfectly sandy. Well, then, even the sand differs in description, and we knew exactly, say, within a mile or two of where we were by even small black specks or little brown or yellow specks, or by perfectly clear sand. Over an area of, say, 40 miles you would find a dozen varieties of sand. In the night-time you would simply pass the lead down below and look at it in the light and know exactly the ground you were looking for.

1932. (*Mr. Archer.*) That would point to the necessity of taking very frequent observations if you wished to ascertain the nature of the bottom in the North Sea?—When trawling in those days when the bottoms were being discovered and explored you never went more than an hour without throwing the lead when the trawl was down—every hour and sometimes more frequently.

1933. That is with a view of seeing whether there was any change in the nature of the bottom?—To see the nature of the bottom.

1934. (*Mr. Spring-Rice.*) Now I suppose there is a great deal of knowledge accumulated about the bottom of the North Sea?—That is so. I was trying to show that it was just before the mind's eye of fishermen the same as the colour of the land is to you.

1935. I meant that a great deal of the work of exploration has been practically done?—It has. So far as the bottom of the sea is concerned to fishermen there is nothing to be learnt—nothing whatever. I suppose I am right in saying that there is not a foot, and that is saying a great deal, but it is not an imaginary expression—there is not a foot of the North Sea bottom but what has been sounded and observed during the last 60 or 70 years.

1936. (*Mr. Archer.*) But records, I suppose, have not been kept?—The records that are committed to paper are the charts which Mr. Olsen has prepared. I think that some time ago I submitted to one department of the Board of Trade, one of those charts showing where we discovered those rough grounds, it is very interesting even to myself, because I may say I have taken a part in it originally. Of course, the thing is really known now, but it was not known until recent years.

1937. (*Mr. Spring-Rice.*) And that information will, of course, be available for the Government if it undertook the scientific study of the North Sea?—Yes. What I am proposing to do for my own information is perhaps to make a model—a plaster model—of the North Sea and show on it all the information I possess. I am very busy, but I hope to do it some day, and to put upon the bottom all the various sands that are found. You have got the description on the chart of the rough grounds, and those kinds of places where you cannot shoot a trawl. To myself that is very interesting, since I have studied other branches of scientific matter it has been very interesting to me personally. For instance, some portions of the Dogger Bank show traces of the old ice ages where the old icebergs have dropped their cargoes. There is the granite from Norway and the north of Scotland, and whenever we find them we bring them in and put them on our docks. Then in another part of the North Sea we have the old sandstone from the Yorkshire coast, showing where they have been dropped. I have collected those bits of information, and they are very interesting to myself, apart from anybody else.

1938. (*Chairman.*) Have you anything else to say?—The question that I have been interested in for a large number of years about those researches of the North Sea is with reference to ascertaining whether there is any reality in a statement that I have made many times about those small flat fish—the position that we find them in. We find them in such large abundance in what we call the Bight of Heligoland—if you know the configuration of the North Sea—the question has been in our minds how it is that such a vast amount of these small flat fish is found in that locality. I have found from my observations that the reason is that the tida carries the ova into that part of the sea, the shores are sandy for miles and miles, it is a suitable place for the ova and it grows; whilst upon our western shores the currents have not got that tendency.

1939. Is any part of that area protected or closed?—No, that is one of the things that we have been asking about, whether if this small immature fish question was gone into, you would not find that there is an area there that might be closed for a time.

1940. I suppose it is frequented by mature fish also?—No, it is not, that is the peculiarity about it—it is not frequented by mature fish. In our early experience of that part of the North Sea some little distance away from where we find those very small fish, there were a lot of large fish below what we call the Horn Reef, but we fished those out, and still we find those small fish. It is a curious thing that in no part of the North Sea where we find the large fish do we find the small ones.

1941. (*Mr. Archer.*) The trade at Hull and Grimsby in 1890 passed a resolution proposing to close a portion of that ground, did they not?—I do not think there was ever a resolution proposing to close a part of that ground. I think the resolution was that we should endeavour to prohibit the capture and landing of the small fish, but I do not think they ever said by resolution that the grounds should be closed. They said that if you prohibit the landing people would not go to this locality to get the fish, because such a large portion of the take was small fish, and such a small portion of it large fish, it would close itself, as it were.

1942. What I was particularly referring to was an answer which Mr. Wrench Towse gave before the Committee of 1893 on the 2nd of May, in which he read a resolution which had been passed at a meeting of the Hull and Grimsby trawl owners?—I should like to see that evidence.

1943. There it is.—(*Handing it to witness.*)?—Yes, I think I remember now. That, of course, was a resolution passed by ourselves trying to restrict ourselves.

1944. Now by that resolution the area which you proposed to close was laid to the eastward of longitude seven degrees and thirty minutes. That is to say in the Bight of Heligoland?—That is so.

1945. I conclude therefore by proposing to close that particular ground you considered that most small fish congregate there?—That is so.

1946. And you consider that there was a greater number of small fish congregating there than there was either to the westward or to the northward?—That is so.

1947. And that observations made further westward would not necessarily represent the conditions in that particular area?—That is so.

1948. (*Chairman.*) Are you acquainted with any similar area into which the pelagic ova drifts and accumulates?—No, I am not. I do not think there is a similar area in the North Sea.

1949. Not on the British coast?—No. We have observations which prove to us that everything floating goes in that direction. I have a copy of a letter, which I intended to bring with me, that was sealed up in a small tin and thrown overboard on the western side of the Dogger Bank. I have the date and the exact position where it was thrown overboard, and the letter requested that if found by anybody they would communicate with the writer. That landed itself on the island of Roma—you will see Roma south of the Horn Reef—it drifted in that direction—I forget the number of days—but assuming it was picked up directly it was washed ashore, I made a calculation—it drifted there and landed itself within a very reasonable time. That confirmed all our observations which had been made

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hitherto, that everything floating in the North Sea has a tendency to go in that direction. We know that our fish boxes—a large number of them are washed overboard—are piled up on that coast by hundreds, and we know that boats which we have lost have floated over in that direction. We have been communicated with regarding boats picked up that have been lost on the lower part of the Dogger Bank, and there is every reason to come to the conclusion that that is the tendency of the current of the North Sea, it seems to take with it all the floating matter, and, of course, the eggs as well.

1950. Have you anything further to communicate?—There is one point that I should like to make mention of if you will allow me. I was asked if I had seen the programme prepared by the International Conference in Christiania. I thought there was a resolution submitted there which we should take exception to. I mean the resolution with regard to the Moray Firth. You are perfectly aware that the closing of the Moray Firth has not given general satisfaction, and we thought that it was rather a stretch for any person connected with the Scottish Fishery Board to have submitted a resolution to an international conference on a question that we ourselves had not yet agreed upon—namely, as to whether the closing of the Moray Firth is a good thing or a bad thing. I think that it was wrong for that resolution to be submitted.

1951. The resolution only went in favour of its being the same all round—an all round closure and not a restricted closure?—The resolution, as I understood it, asked the International Conference to consider the question respecting the closing of the Moray Firth as an international question, and not an English one. We have always felt that it is a dangerous thing to permit our own or other countries—and I am very strong upon this—to slice the North Sea up for their own particular use. We have sliced up the North Sea and extended our national boundary, and as sure as we are Englishmen if we assent to the principle the other nations, who are alive to their interests, will slice up the east side of the North Sea, and we shall be crushed out. This will be very injurious to our interests.

1952. But it is precisely the contrary that we have done in the Moray Firth; we have shut out our own fishermen, and let in the foreigners?—Well, if we get that recognised as an international grievance they will keep their vessels out of the Moray Firth, and also slice up their shores and keep the English out. That is the difficulty that we see of extending the boundary of any country beyond the three miles limit. It is impossible to see where it will end.

Mr. J. A. Travers, called; and Examined.

Mr J. A Travers.

1953. (*Chairman.*) You are a member of the Fishmongers' Company?—Yes.

1954. And you are good enough to come before us as representing them?—I have had a good deal to do with the Fishery Committee of the Fishmongers' Company, and I am a sort of fishery representative in that way.

1955. You are also a member of the Royal Commission on Salmon Fisheries, now sitting?—Yes, in the capacity, I believe, of representing what the Fishmongers' Company have done.

1956. Have your Company devoted any attention to the subject which has been referred to this Committee?—There I am in a little difficulty. The subject is so wide that I am not very clear as to what exactly is the subject of investigation.

1957. In the first place there is the proposal, which His Majesty's Government have agreed to join, of the international scheme of survey of the North Sea; is that, in your opinion, a hopeful project?—Part of my business here is to urge upon the Committee the necessity of joining with the other nations in carrying that out. That was one of the special points which I had to bring before you. I am not aware whether the Government have done anything, or are prepared to do anything. I do not know whether I may take it at all that the Government look on it more favourably than has been published. I believe we have had in answer to a communication between the National Sea Fisheries Association, which is a practical part of the Fishmongers' Company, and the Government, a notification that the subject was being considered in a favourable way by the Government. That is all I know officially at all. Part of my brief here, I may say, is to urge that the Government should take part in that investigation.

1958. It has been suggested to us by other witnesses that Great Britain will be acting rather the part of the monkey to the Continental cat, pulling the chestnuts out of the fire; that is to say, that the knowledge obtained, supposing Great Britain should co-operate in this investigation, would be of more use to Continental fishermen than to British fishermen?—I have heard that, and it has been rather impressed upon us, especially by the Hull and Grimsby interest, and there is something to be said for it, I think. So far as I have been able to ascertain for the information of the Committee, I think that if we accept information from the skippers and other fishermen we should have to treat a great deal of it as confidential. The idea amongst the trawlers, so far as I have come across them—we have a good number of them in the National Sea Fisheries Association—is that at Grimsby, at all events, all the knowledge that is useful to Grimsby fishing is already in their hands, and that what they do not know is scarcely worth knowing. Doubtless there is a good deal to be said for that as regards the immediate obtaining of fish from the various grounds. But I do not think that we should pay too much attention to that. It is the usual feeling exhibited in numerous trades and numerous guilds, the idea that the knowledge they have is the only knowledge there is, and the only knowledge worth having. I think, to put it in other words, that the benefits we should gain from joining in these investigations, as proposed by the international conference, would more than balance any giving away of information that might result. I know that that is not the opinion of some of the men. I was talking to one of the large trawler owners yesterday, and I thought he was coming here—I asked the Secretary whether he was coming here. He rather took my view, that the gain of general information would more than counterbalance the loss of their own special knowledge. He said very boldly and very clearly that we were the best fishermen and the best sailors, and that he did not care anything for the Continental men; he could hold his own even if they had this knowledge.

1959. At all events, you would be inclined to expect that the knowledge we gain by co-operation with other countries would enable us not only to catch the fish, but to protect them and develop the fisheries?—Certainly, and if I may add to that there is also the fact—it seems to be a fact—that without the co-operation with the other nations we cannot expect to do anything.

1960. We may take it as the strong opinion of your Company that Great Britain ought to co-operate in this international scheme?—Yes.

1961. Is there anything that you think should be done at home?—In connection with that scheme?

1962. Yes, or in connection with the general development of fisheries—I will take the international conference. I would strongly urge that, as this conference only proposes to deal with the North Sea, while we are about it we as a nation should carry on the same investigations or similar investigations as regards the rest of our coast. The fullest extent of this international conference inquiry embraces, we may say, our eastern coasts, and possibly a portion of the southern, but we think it should be carried out, if possible, on the same lines to make it valuable to us Britishers, as regards the western coast, the Irish Sea, and, as far as possible, the western waters of Ireland as well. It would be quite incomplete and insufficient for our personal purposes if we did not collate the information on both sides of the coast.

1963. Does the machinery exist at the present time for that? In your opinion, is the existing machinery adequate?—Absolutely inadequate. I take it perhaps the largest amount of machinery for these purposes is shown to us on the north-eastern side—the committee for the Lancashire and Western Sea Fisheries District is the term, I think, but, at all events, that side—and in the Marine Biological Laboratory at Plymouth. As I understand, there is very little on the east coast at all. In Scotland, I believe, there are two; there is the laboratory connected with the Scottish Board, and there is one at St. Andrews—what we call the Gatty

Laboratory. I do not think the Marine Biological and the Scottish stations could cover the whole of the east coast.

1964. With their existing staff?—With their existing staff I am quite sure that they could not. Of course, it is quite out of the question that their ship or vessel staff would be any good in their present state. A vessel able to keep the sea as long as an ordinary trawler keeps the sea would seem to be the smallest investigation vessel necessary.

1965. Have you any view on the general question of administration, whether it would be better to maintain the existing national distinction in the Board of Trade and Scottish Fishery Board and Irish Board of Agriculture, keeping them independent of each other, or whether one central authority would be more efficient?—I am strongly of opinion that a central authority is necessary, but equally strongly of opinion that we should not interfere with the present what I may call "local" arrangements. A new department, rather, is wanted to deal with the new and larger work. I would not interfere with the Scottish Fishery Board, which seems to be doing excellent work, and I would not interfere with the Irish for many reasons, but I think that a central London board of control to prevent overlapping of work and to indicate—it would perhaps be better not to say instruct or direct—the direction of inquiries, would be useful; in fact, absolutely necessary.

1966. It has been suggested that the supervision of that central authority might be undertaken by the Board of Agriculture?—I am not acquainted sufficiently with the Board of Agriculture to say whether they could do it, except so far as that I believe very fairly good work is done in Ireland by the fishery arrangements being under the Board of Agriculture.

1967. It is merely a question of staff, is it not?—Possibly. I think, though, that the tendency of fishery matters should not be towards agriculture; I am inclined to think—this is only my personal view—that the interests of Great Britain are so large as regards her sailors that if there is a tendency towards any department it should be towards the Navy—that the boats that are wanted and are constantly being asked for in connection with trawling fleets, the boats which are necessary in connection with guarding the in-shore fisheries from trawlers, and possibly, also, the boats which are connected with making naturalists' inquiries, might very well be connected with the Navy. The fishing interest is such a large national one, and the very existence of England depends so much upon its Navy, that I would, wherever I could, connect the two together. I would rather not send it to agriculture—I would rather send it to the Navy.

1968. You think the interests are rather with the Navy than with the Board of Agriculture?—Certainly, as regards the number of vessels. There are also, I understand, still a number of vessels—mostly sailing vessels, I think—in connection with the Customs and preventive service which are out of date, which might very well be got rid of, and in place of those, modern vessels supplied which would do to a certain extent some of this work which is necessary, and guard our fleets and keep them in order, because they want keeping in order very much. The tendency should be that way rather than towards agriculture. I found a certain number of the larger trawling men agree with me, but probably—I must say that—because they want a gunboat or a Government boat here and there with their fleets in foreign waters.

1969. Then you have some other recommendations of which I have notes here; for instance, the establishment of a museum; the utility of that is fairly obvious, is it not?—I hope so, but for many a long year, since Buckland's death, as members of the Fishmongers' Company, we have been endeavouring to get some recognition of the usefulness of a museum, and some attention to the Buckland Museum, such as it was, as a base for going upon. I have been a member of one or two deputations and one thing and another, but we can get absolutely no response whatever. We think, instead of being under the Science and Art Department, or the Department under which it is at present, it should be a fishery matter. If the usefulness is admitted I will not trouble you with any further views on it, but I think that I might mention two points in particular, which rather apply to freshwater fish. One would be the examples of fish at various stages of development, available for anyone who wanted to see them, particularly our watchers and fish representatives on the coast, and also I think it is very essential that we should teach some people in one part of the district what the means of poaching are in another. I think the gain in teaching a keeper what the poachers' dodges are will much overbalance the disadvantage of teaching the poacher in one district how to take up a new mode, which has been put before me as a difficulty in connection with the matter. Those would be two special points. As regards the sea fisheries, I think it has been admitted by what has been done all round the coast in the endeavour to teach classes of sailors something about the fish they have to deal with, that something of the sort is necessary. South and west at all events we have classes of fisherman being taken in hand and taught.

1970. You have some views as to the protection of immature fish?—As a member of the Fishmongers' Company I almost exist for that purpose. We have been fighting and endeavouring for eight or ten years, one year after another, in one Bill after another, to get something done. As connected with practical men I may say it is extremely difficult to find any among practical men who know their business who do not agree as to the absolute necessity for some such Bill as has been constantly suggested for the prevention of the landing and sale of immature fish.

1971. You think that that should be dealt with without waiting for the result of the international scheme?—If we wait for that, as a practical man, knowing something of the ways of scientists, I think it will be, not five years, but more likely fifteen years before anything satisfactory will be obtained.

1972. The last witness before us had a suggestion about the waters round Heligoland, which it seems are specially frequented by immature fish; in fact, it seems to be a large hatchery; his suggestion was that the larger number of immature fish came from that place, and that was an area which ought to be protected. That, of course, could not be undertaken without international co-operation?—Quite so, and there is my difficulty. I know a little, though not very much, of scientists and their ways, and I know enough to know that they are not in a hurry to report, and the further they go in their investigations the more they find something further which they wish to clear up before they will commit themselves to anything. The recommendation, if I may refer to that, of the Committee on the Immature Fish Bill was come to before it was proposed that there should be this international conference on the matter, and that seems to me to be very strong.

1973. (*Mr. Archer.*) No?—Subsequent to it, was it?

1974. There had been a conference at Stockholm. It was subsequent to the Stockholm Conference?—I did not know they had agreed to anything then. I am technically wrong, but I thought the recommendation on the Sea Fish Bill had not been come to subsequent to the report of 1901.

1975. There is practically no difference between the report of 1901 and the report of the Stockholm Conference in 1899?—I quite agree, but the last was the confirmation and the putting in force of it. They proposed in 1901 that they should begin this year.

1976. And they proposed in 1899 that they should begin the year before?—I did not know that. I stand corrected. The recommendation seems to me so strong that it would be difficult to get over it until the scientific report had been obtained. I do not know we are to get over—of course Parliament can do anything—that rather strong view. The arrangement as to the international treatment of the subject and so on would lead one to expect no help from Parliament until the report came, which as I said before certainly must be five and probably ten years hence, when the fish we want to benefit will have died.

1977. (*Chairman.*) There is a tendency to procrastination in Parliament?—May I here suggest—it is only a suggestion which has been made at our Committee, and at the National Sea Fisheries Committee—that if a Fishery Department was established there might be ways, I will not say of getting round this decision of Parliament, but of protecting some of the fish by an Order in Council, which I believe is the mode, or some temporary departmental rule.

1978. (*Mr. Spring-Rice.*) May I ask you this. In making that suggestion have you in your mind any statute which gives power to any department of Government to make an order in council on the subject?—No, I have no definite statute in mind, but as we are rather proposing the creation of a new, or the enlargement of a present, Government Department, looking at the very large powers there are for Fishery Committees as re-

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gards territorial waters we consider that it might well be possible to deal with anybody coming into those waters, and in that way prohibit the landing and sale for a time.

1979. You mean that if there is a Bill for making a new Department of State, or for the re-organisation of a Department of State, that Bill might contain the power for a new Department to pass such orders in council?—Exactly; that is so. We are met, too, with the present congestion of business in Parliament, with this very strong paragraph, and with the knowledge that we shall get no report from the scientists for many years sufficient to over-ride this, and one has to look round and see what other possible way there is of doing what we consider necessary to save the fisheries from destruction.

1980. You are aware the Government would have no such power unless it were given them directly or indirectly by legislation?—I confess I am not a Parliamentarian enough to know that.

1981. I think you may take it that that is so?—I looked at it somewhat in this way, that the Scottish Fishery Board have very large powers as regards Moray Firth. They prohibit certain things there, and it seemed to myself, as a man in the street, that the powers wanted for prohibiting the landing of small fish at a particular port, because the landing of fish caught in the Moray Firth is prohibited, say, at Aberdeen—were not so very different but what, with a little ingenuity, they might be brought within bounds.

1982. (*Chairman.*) There is some analogy to what you indicate in the Salmon Acts, is there not? The district fishery boards have the power to alter the statutory close time?—They have very large powers.

1983. Subject to the approval——?—Of the Board of Trade, of the Central Authority. I think an enquiry is usually made in that case. However, it is only a suggestion in the very difficult position in which we are placed. Both the National Sea Fisheries Association, and my Fishmongers' Company feel that it is very important that if possible something should be done in this direction, if only to go hand in hand with the scientific investigations. We should then, if I might suggest it, find out very definitely and very promptly whether the skippers knew where to go for small fish, and where to avoid them.

1984. (*Mr. Archer.*) I heard you make one very strong statement, viz., that we could do nothing without the co-operation of other nations: are you aware of what the trawling fleet, for instance, of this country is as compared with that of other nations?—I am not, but I should put it down roughly as 80 to 1.

1985. And do you think, therefore, that if certain regulations were made with regard to our own boats it would not have a very considerable effect?—It had not occurred to me in that way, because I know, and you probably know, our English sailors, and the very strong feeling which would be raised. Quite possibly it would not be practicable, because of the very strong feeling which would be raised if the foreigner did what they were not allowed to do. I gather you mean a prohibition to our own men to trawl on certain grounds, which would be the practical result—something of that sort—enforced by, say a gun-boat being present?

1986. Well, I did not mean any concrete idea of that kind?—That is what occurs to me as a mode of doing it. Taking Heligoland, for instance; we could prohibit our men from trawling there. I fear that the love of gain and the love of a certain amount of mischief on the part of our sailors would cause a change of flag to a very large extent if that were done. I am only taking Mr. Archer's views that we could prohibit our men from trawling in that way.

1987. (*Chairman.*) You could in the Moray Firth, but could you prohibit them in Heligoland?—We could fine our own men when they came back from fishing there; that is all we could do. I think. If a boat, say Grimsby 401, had been reported by the gun-boat as having fished in that water, when it came back you could fine the man and forfait the boat.

1988. (*Mr. Archer.*) Then I see you recommend that something should be done to prevent the destruction of immature fish while waiting for the result of the scientific investigations. Now is not one of the principal objects of those investigations to ascertain how, where, and when we can protect these small fish?—Yes, I take it with the special view of international legislation only, or more particularly. As I understand it, other nations have certain regulations—I confess I have not been through them very thoroughly—with regard to sea fisheries, restrictive legislation. They have some restrictions, or had at one time: we have none. I want to urge that we should have some.

1989. But is not the reason why we have none, and why that Bill of 1900 was not passed, because we had not sufficient information as to the size of the fish frequenting certain places?—You are asking me a rather delicate question. On the face of it, yes; according to my private knowledge, certainly not.

1990. But why certainly not?—Because just in the same way we had a difficulty about crabs and lobsters. A few voters connected with a few gentlemen who represent sea districts are so powerful that any reason or no reason is seized upon to prevent this Bill going through. I do not for one moment think that the real reason was that we had not sufficient information to do something, but there was a desire at any cost to postpone it, and the line of least resistance was to say we had not sufficient scientific information to say what the sizes of the fish were. I am speaking as a practical man.

1991. But besides being a practical man I think you are also treasurer of the Marine Biological Association?—Treasurer, yes.

1992. Did not a witness from the Marine Biological Association come forward and say that the Bill would be ineffective unless the size were increased to 13 inches?—I think so, but I laid stress on the word "treasurer." I am only an unscientific member who looks after the finances of that Marine Biological Association; I am not a scientific man as regards that, and I may say I disagree with him entirely, so far as my information obtained from other scientists goes. I have no knowledge of my own; it is only what I gather from other scientists and from the practical men who are trawling in the North Sea.

1993. Do you know upon what scientifically ascertained facts that opinion was based?—I understand the question of maturity of breeding was the chief one, but I know also as a practical man that the difference between a sole of a definite length from the North Sea and one of same length from the waters of some of our southern bays along the Devonshire coast is so great that one fish has practically no flesh on it at all, and the other is an extremely marketable, useful fish. I see great difficulties as regards length, but something must be given and taken. I think we have had four or five special meetings of fishermen at Fishmongers' Hall, what we may call the Fishery Parliament, debating this question of undersized fish, at all of which I have been present.

1994. Was not the size limit as regards maturity for plaice in the North Sea 17 inches?—Doubtless.

1995. And was not the conclusion which the representative of the Marine Biological Association came to, or the evidence, rather, which was given by him before that Committee that 13 inches was the limit below which no fish should be taken?—I am not properly up in it; I do not recollect, but I will take it from you that that is so most certainly.

1996. I see that in answer to Question 3658 he said: "We have figures showing the relative numbers of the fish of different sizes on those eastern grounds, and our view is that the proportion of plaice and soles below 8 inches from those grounds, and the proportion of turbot and brill below 10 inches from those grounds, is so insignificant compared with the number of immature fish above those sizes that the trawlers would not be prohibited from going there and working"?—That is the individual opinion of the man who was giving evidence. Against that I would put the constant evidence of a number of the trawlers that the question of an absolute half-inch or inch is not of so much importance as the prohibition of a certain size, of some size I may say. If I may go to another example, good is done, or is proposed to be done, by prohibiting the taking of small fish of the salmon and trout description under a certain length. It is not contended in the least that all above those sizes should be taken, but that it will preserve a certain number. And so here with regard to the prohibition, supposing we are scientifically informed that 13, 14, or 15 inches would be the only limit, useful practical work would be obtained if we could get a general consent to something below that. Nobody will run close to the limit; that is what we are told by the trawlers.

1997. I think that the contention was that unless the

size were as much as 13 inches it would not prevent the trawlers going upon the small-fish grounds, and if the trawlers trawled on those grounds, the small fish caught would be destroyed, and therefore there would be no use in returning them into the water. But apart from that point altogether, you cannot tell me the scientifically ascertained facts upon which this opinion was based?—No. That is where I would urge the difference between the scientific result absolutely obtained and a good, ordinary, common-sense, practical basis of working. May I give an example? I hear from these trawlers that supposing, say, 10 inches was taken for any fish and was recognised as a fair thing, practically fish half as big again would be rejected; they would not go for them. They will not go near the limit if the limit is recognised as a fair one. Of course, scientifically a man who is giving his evidence may be upset by the production of one or two specimens; he is bound to be very careful; but in the ordinary, every-day work of life we have to take a compromise. At all events the view I am here to urge is that a compromise would be very useful, if not as useful as we may hope to get when we have the report of the international scheme.

1998. Let me put just one other question: are there any scientifically ascertained facts to support this statement?—I cannot say. You may take it that my connection with the Marine Biological Association is a financial one, that my information there is gathered from the different men I meet, but is not followed up personally. I am, perhaps, fit to speak of what the trade generally would be prepared to do, and what they wish for. They wish for something, scientifically correct or not, because they think that good would result from it. That is all I can say, and it is reduced to a minimum.

1999. I notice that you have put down here a number of points upon which you think that information is required?—You mean the sizes of fish and so on?

2000. Yes?—Those are rather duplications of what is required by the International Conference, but it is that we want to know that about all the waters, not only the North Sea but all the way round, and those are points which we think would be extremely useful, not to give to the foreigner, but to know for ourselves as regards the Irish Sea and so on.

2001. I think we are all agreed that it would be very desirable to have information on these points, but the question which I wish particularly to put to you is whether you have considered the method of investigation by which this information should be obtained?—There is the very greatest difficulty. Personally, from what I have seen of them, I mistrust the information which we could obtain in the cheapest way from the skippers of trawlers or fishing vessels. With the very best intentions they are not educated men; they are not educated enough to know the amount of accuracy which may be required in their returns. And they are a little inclined, like all fishermen, to give information which will put their friends off the particular best grounds which they may know of.

2002. Do you think that you could not find a certain number of reliable skippers who would give you information as to the place where fish were caught, and the time when they were caught?—Yes, I am quite sure you could, but it would be difficult to eliminate those who would give true answers from those who would not give correct ones. Do you follow me? It would be difficult to find out your men. I am sure there are a number who would do it, and might do it very well, but I do not know how you are to find them.

2003. But do you not think that anybody who was conversant with these men, who is known to them, would in course of time at any rate ascertain from his knowledge of the men's personal character those whom he could trust and those whom he could not?—The personal equation is difficult to deal with. I think that would be the only way. I think, for instance, a certain number of men who fish in South Devon would give information to some of our men at Plymouth that would be reliable, but you would have to depend upon the naturalist, to give him a name—I will not call him a scientist—the local man, to pick those men out on his own personal responsibility, and then he might be sold. They are so full of prejudices. There is one man, for instance, there whose information I understand is most useful and splendid so long as you do not get him on his particular tack. The particular point on which he has a bee in his bonnet is with regard to fish hearing, and hearing long shore noises as much as five miles away at sea. Get him on that, and if he thinks his information tends in the least in that direction it is unreliable.

2004. I take it you would not ask these men to give you opinions; you would supply them with a very simple form of return which you would ask them to fill up?—Yes. It would have to be very carefully done.

2005. Are you acquainted with the steam fleets that fish out of Hull for the London market, and send their fish to London by steam carrier?—Only second or third hand. I think for them a man like the man I was talking to yesterday, Oakley, or some of the larger men would be more useful, but there, again, if I might suggest, you must be careful who your men are. They are excellent men, but——

(*Mr. Archer*) If you do not know about them I will not press the subject.

2006. (*Chairman.*) We should like to hear anything further which you may wish to say on other points?—Amongst the questions which seemed to be put before me was the mode of getting information, and so far as I can learn as regards boats one of the best modes of getting information would be a trawler of the character of a good steam trawler accompanying the fleet, where the accommodation at present used for fish and ice would be taken out and room made for two or three naturalists and their work. That, I gather, would be one of the best ways of getting much of this information. That is one of the questions which was rather put before us, as to the means. As regards the cost I have prepared, in case I was asked, some answers, but they are of course very vague, and unless you specially want it I do not think it would be worth taking up your time. They are as to the cost of biological stations, the cost necessary for this department, and so on. They can only be guesses, but not knowing what I might be asked I covered the ground as widely as I could.

2007. The costs would have to be faced, anyhow?—Yes.

2008. What I gather from you as most necessary immediately is the protection of fry on the British coasts; why do you limit it to the British coasts?—Because I have not power to go beyond. We would do what we could. Of course, it ought to be beyond.

2009. You have already shown you would prohibit immature fish being landed from beyond?—Yes, and we think from what we hear that by prohibiting its sale stopping the catching or landing anywhere, at all events landing. The various continental ports provide but a limited market at any price for the smaller sorts of flat fish; for the largest portion of these small fish come to English ports, mainly to London, where a price just barely remunerative is to be obtained generally. Therefore, if by any arrangement the landing and sale of undersized flat fish can be prohibited in England the markets elsewhere may be neglected, as too small to make it worth a trawler's while catching these fish if he can possibly help it. In fact, England need not wait till other countries join her, she has the whole game in her hands and can make the rules. I am informed that fish which cannot be sold on the Continent, for which there is no market, are brought to English ports; undersized fish that they will not have anywhere else are brought to English ports, which seems to me rather a strong reason for some legislation.

2010. You cannot give us a specific case, can you?—I think I could obtain them. I will endeavour to do so.

2011. It would be interesting to us to have them?—It was given to me very definitely indeed by a trawling man, and confirmed. I will endeavour to get it for you.

2012. Thank you. You do not think there is anything else you wish to say?—No, except that I should press very much the creation of a department having charge of all questions relating to fisheries in sea and rivers, and able to transact the business of all three countries together, a department organised under an independent head with a recognised position in the official hierachy, with a staff selected for the management of the affairs of fisheries and employed solely on those duties, and with full responsibility to control and take in fisheries, not only sea but fresh-water as well. It is difficult to give an estimate of the great advantages which might result from a central control under such auspices. Might I add further that as regards many of the Fishery Committees they seem to have powers which they are not able to exercise. Under 54 and 55 Vict. cap. 37, and under 51 and 52 Vict. cap. 54 the Fishery Committees have very considerable powers indeed, but they cannot be exercised, or could not be exercised, unless they had patrol boats and a larger area.

2013. You refer to the difficulty of police?—Police purposes, and looking after their own districts, and one

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thing and another. A central power might induce a number of them to combine together in the same way that fishery committees on the Lancashire and north-west coasts have combined together. Then they could have a boat at no very great expense; they could have a larger area to assess, and they would do more good. It is no good having two or three small fishery committees—the south of England is cut up into five small fishery districts—unless they are controlled.

2014. May I ask, did you not receive a good deal of evidence to that effect before the Salmon Fishery Commission?—Yes, as regards the salmon fisheries.

2015. As to the inefficiency of small local boards?—And ignorance—inefficiency, ignorance, and unfitness in every way. They want to go to school first before they are even fit to spell the words 'salmon fisheries," I think. Of course, the sea fishery committees have very much larger districts, but it equally applies to them. There are cases where there is no desire to do the work, no knowledge of how to do it, and no power really to do it.

2016. You want to have a local body with an adequate assessable area?—That is really the point in these fishery matters. The sea is not divided up into fishery districts by hard and fast lines and nets. The whole of the south of England, for instance, is much the same. The district which the Lancashire Committee have got, which extends from Cumberland right down to Cardigan Bay, is the sort of district which is wanted. The Bristol Channel would form another district by itself. The south coast, possibly from Land's End to the Thames, would form another district. That is the only way to do any real good.

2017. Then they would be able to undertake a certain amount of police work for themselves?—Yes, leaving at the same time as much local home-rule as possible to the various smaller divisions, but bringing them together probably by a working committee of the whole combined, who would be the executive.

Mr. J. T. CUNNINGHAM, called; and EXAMINED.

Mr J. T. Cunningham.

2018. (*Chairman.*) You are fisheries lecturer to the Technical Instruction Committee of Cornwall?—Yes.

2019. And you have been so employed since 1897?—Yes.

2020. Doubtless there are points which you wish to bring before the Committee in the interests of the fishermen of your district?—In the interests of the fishermen of my district? I cannot say that I have been considering them very particularly in connection with this Committee.

2021. I read upon your notes that you have given attention chiefly to those subjects which were likely to appeal to the fishermen on account of their direct practical utility?—Yes, under the instructions of the Technical Committee, but as I understand the matter, the Technical Committee is perfectly well prepared with authority and funds to carry out investigations of that kind. They are not exactly investigations of the sea fisheries or the sea-fishing grounds. I may say at the same time there was this distinction between what I could do under the Technical Instruction Committee and what might be done in the investigation of sea fisheries, that the Technical Committee was perfectly qualified to carry out any instruction or investigation the results of which could be applied by the fishermen for their own benefit in their own work, whereas the results of the investigations of deep-sea fishing were such that, however important or beneficial they might be, they would have to be carried out by some agency quite independent of the fishermen.

2022. What are the subjects in which you chiefly instruct the fishermen?—Those I have put on my notes—the curing or preservation of nets, the artificial cultivation of oysters, and the curing of fish, as far as any improvements are probable. Then we have done some hatching and rearing of lobsters. There is another undertaking—we have to teach the fishermen as much elementary natural history as possible in order to get them to appreciate and be interested in the artificial fertilisation of spawn on their own boats, a matter which at present has scarcely been done to any practical extent among the fishermen.

2023. There is rather a deficiency of accurate knowledge on the subject, is there not?—Oh, yes, there is a great deficiency of accurate knowledge.

2024. I mean among men of science like yourself?—No, I do not think so.

2025. Are you prepared to say what proportion of spawn may be fertilised at sea artificially?—I am prepared to say that all ripe spawn can be fertilised artificially without any trouble at all.

2026. Does not the question depend upon what proportion of spawn is ripe?—Yes. Only the spawn can be fertilised which is ripe in the fish when it is caught. You can only fertilise the amount of ripe spawn the fish contains, which may be a very large quantity, perhaps half the total quantity produced by the fish, or it may be only 5 or 10 per cent. if the fish is only beginning to get ripe. If the fish is caught just before it is ripe, or after it has spawned, it will be none at all.

2027. Do you find the fishermen take much interest in that?—Not so much as I should like. I think they would take more interest if they were better instructed. It is ignorance generally which prevents them taking an interest in it, and also their conviction that they have not the time to attend to it owing to the difficulty of doing anything beyond their work when they are at sea.

2028. It does no doubt involve a great deal of trouble?—Yes, a great deal of extra labour, and the fisherman does not appreciate any trouble which is only for general benefit and not for his own direct benefit.

2029. Has the attention you have paid to the hatching and rearing of lobsters been attended with any perceptible increase?—We have not gone so far as to attempt an increase. The way in which I have been working at lobsters is this. Of course, it is perfectly simple and easy to hatch any number of lobster larvæ from the eggs one can get. There is no difficulty about it at all. One could hatch 50 million as easily as fifty; it is only a question of the amount of spawn one can get. But it is the general opinion of those who have considered the subject, and my own opinion, too, that the turning out of newly hatched larvæ is not likely to produce a very great effect, because there is no doubt that the mortality of such larvæ is very great indeed, whether they are put into the sea from a hatchery or whether they are hatched naturally. The object with which I have been working, and also the object of those working in America, is to find the proper way of rearing these larvæ in the hatchery, in tanks, through their immature stages until they are perfectly developed lobsters, which is when they are a month or five weeks old. Then they crawl like lobsters, and have got their proper organs and characters. If we could do that on a large scale and put the lobsters into the sea at that stage, we should be able to produce a much greater effect upon the supply.

2030. Have you any designs for rearing ponds?—It does not require ponds at that stage; it only requires hatching troughs. Last year I built a hatchery at Falmouth for that very purpose, but it was only finished towards the end of the season, and up to the present moment it cannot be said that it has really been tried. We succeeded in rearing a few at the end of the season last year, but I did not expect to be able to make a proper trial of it because an apparatus of that kind naturally contaminates the water when it is new, and it requires some time to get into proper order. I think if we can use that hatchery this season, we shall be able to prove that a considerable number of lobsters in that stage could be reared.

2031. What is the annual expenditure of your committee?—About £600—that is the Technical Committee. Of course that is quite independent of the Cornwall Fisheries Committee. In the Technical Committee the teaching of the fishermen is only one branch of the general educational work. That work is divided into three branches, one for mining, one for agriculture, and one for fisheries.

2032. I think you have made several voyages yourself in the North Sea?—Yes, in 1895 and 1896.

2033. We have had evidence about those parts of the eastern shores of the North Sea where undersized flat fish are found in great numbers?—Yes.

2034. Is it your opinion that these places ought to be protected?—Yes, certainly. I made two rather long voyages on those grounds myself, in order to examine them. The observations were published by the Marine

Biological Association in their Journal. I have them here, giving roughly the numbers of plaice which were brought to market, the numbers below a certain size, and the numbers thrown overboard.

2035. Taking the area round Heligoland, is there any corresponding gathering ground for immature fish on the British coast that you are aware of?—None so large or extensive, but I am aware, of course, that there are gathering grounds all along the coast. There are some in the Humber and the mouth of the Wash, and all along the Lowestoft coast, but there is not such a large extent of shallow ground, and the shallow ground does not seem to support such a large crowd of undersized plaice.

2036. How do you account for the congested areas?—I think it has been shown by the Scottish Fishery Board to be very largely due to the set of the current, that the eggs of the plaice from a great part of the North Sea accumulate in that corner, and the young fish are developed there. The mere fact of carrying them there would not account for their successful life if the conditions were not favourable, but at the same time there is a great abundance of food there. I showed that there was an enormous quantity of small razor shells and molluscs of other kinds on which the plaice were feeding. It is the most suitable food for them.

2037. Would you consider that the protection of places such as this would be a more hopeful proceeding than the artificial propagation of fish?—It is difficult to say which would be most successful.

2038. Is it?—Yes, because we have not enough evidence on either side, I think, to say which would be most successful.

2039. But from which would you anticipate the most results?—I think that even if the protection of the young fish were most efficiently carried out, it would not be sufficient to stop the diminution of the fish supply by the fishing operations of steam trawlers and so on. Taking the example which was worked out by Dr. Fulton in Scotland, which I read rather carefully, he had the whole of St. Andrews Bay and the whole of the Firth of Forth closed against trawlers, and as far as anyone could say there was no undersized fish caught there for five years. He had the number of fish on those closed grounds and the open grounds outside them statistically examined all that time, and he found at the end of the time there was a diminution in spite of the protection. He attributed it, I think very rightly, to the fact that in spite of the protection of the young the total number of mature fish was being diminished at such a rate every season that the production of young was very rapidly decreasing. It would not matter how much you protected the young fish if the supply of them was rapidly being reduced.

2040. Simultaneously with the destruction of the food fishes there is a destruction, an abnormal destruction, of the predaceous species also, is there not?—I do not know about that, I have thought about that, but it does not seem to be so in the case of the plaice. It does not seem to me that the destruction of predaceous fish such as the angler compensates for the destruction of the mature plaice. I think it is pretty certain from the evidence we have that the destruction of the angler, which is very well known, does not at all compensate for the destruction of the mature plaice.

2041. In your voyages in the North Sea, did you notice what proportion of predaceous fish were landed, such as dog fish and anglers?—I have put down as accurately as I could under the conditions the numbers of all kinds of fish taken and brought up on deck, both anglers and worthless fish as well as those which were valuable in the market.

2042. It would not be safe to assume, would it, that because human beings effect a great destruction of fish, and destroy a great proportion of every generation, that therefore the general stock would be depleted?—I think there is a great deal of evidence in different departments that it would be safe to assume that, when we consider such a matter as the whale fishery, or the Indian and Burmah forests. Of course the forests are an exactly similar problem to the fisheries, and it has been proved over and over again that if the exploiters, whether natives or European capitalists, are left to themselves with regard to any product for which there is a great demand in the markets, in a few years they will totally exterminate and destroy the supply.

2043. On the other hand have you compared the productiveness of the Yorkshire grouse moors at the present day with what it was 30 years ago?—No, I have never had any knowledge of grouse moors.

2044. I commend the matter to your attention; it is an interesting problem?—But then they are preserved.

2045. Undoubtedly, they have a close time?—There is no close time in the sea.

2046. No, but I made this inquiry in connection with your suggestion that there should be certain protected areas for the growth of young fish?—Yes, I think the protected areas would do a certain amount of good, but what I say is I do not think it would be an infallible preventive for the diminution of the supply. On the other hand, if we knew any means of preserving a certain minimum of parent fish we need not take any trouble about the young ones.

2047. I am not expressing any doubt as to the soundness of your conclusion; I only asked you if you had considered certain other features which seemed to bear upon it?—I do not wish to say that I am prepared to recommend any method of preserving or closing areas for the protection of the mature fish; I only put it theoretically that it would be more efficient, if possible, than protecting the young ones.

2048. You feel the want now of a central authority in scientific work?—Certainly I think there should be a central authority. It has always seemed to me a great anomaly that there should be a Fishery Board for Scotland provided with powers and funds for scientific investigation, and also in Ireland, and nothing of the kind in England.

2049. There is a department of the Board of Trade, of course?—It is not provided with any funds for scientific investigation, and it has not carried out any scientific investigation.

2050. But the Marine Biological Association does receive money?—It receives £1,000 a year from the Government, but I am not quite satisfied as to the advisability of leaving an independent private association to take the place of a Government Department.

2051. Have you any opinion as to what department has most affinity with the fisheries, the Board of Trade, the Admiralty, or the Board of Agriculture?—I should think it would be most reasonable to connect any new Department established for scientific purposes with the existing department for fisheries—simply adding a scientific branch.

2052. It has been suggested, as fishery matters are inseparable from police operations, that the Admiralty would be the most natural department to deal with fisheries?—As far as I know the history of recent years the Admiralty have steadily declined to have anything to do with it, and in all matters concerning suggestions for police or the collection of information, the Admiralty always expressed their dislike of undertaking any such duties. If it were arranged that they should undertake them I think that they would do them unwillingly, and that there would not be a real interest in the matter at the Admiralty.

2053. You think they would not get a corresponding benefit in the recruiting ground and the manning of the Navy from among the fishermen if the bonds were drawn a little closer?—No, I should not think there would be any result in that way.

2054. (*Mr. Spring-Rice.*) I see that you teach your Cornish fishermen among other things the collection of statistics and investigations. They are taken by means of log-books—I suppose you mean by fishermen?—The observations are taken by fishermen, and I collect the log-books from them.

2055. Do you find you are able to train them to make good observations?—The observations are not altogether satisfactory—not so good as they would be if they were taken by properly qualified men.

2056. Do they extend beyond what one may call the fishermen's trade? Do they include such a thing as taking the temperature of the water?—They include surface temperatures. The men are supplied with thermometers and take surface temperatures, and in a great many cases I find those temperatures are scarcely trustworthy, because I cannot be certain how far they are wrong. I have reason to suspect them in many cases, and am not able to trust them.

2057. Are you hopeful that after a time they will be able to be better trusted?—Yes, certainly; if the general level of scientific training was increased amongst the fishermen they would be much more efficient as observers.

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2058. Do you think in that case you could get useful observations from them?—I think we might get a certain amount of use from their observations, I mean their observations would be useful to a certain degree, but I do not think such observations would ever supply the place of systematic observations by a scientific man.

2059. But recognising the fact that the sea is a very large place, and that you cannot have scientific men taking observations all over it at one time, would you say that fishermen might be taught to give observations which would be useful as a supplement?—Yes.

2060. Do you attach importance to it?—I think it would be very useful as a supplement. If you were able to collate the observations with those of more qualified people you would be able to judge how far they were trustworthy.

2061. I mean in reference to a general survey of the sea such as you recommend; would you hope to get some useful assistance in that way?—No, I do not think I should in the case of a systematic survey, because there is so very much more to do than merely to take surface temperatures.

2062. Now, as to the information which they can give as to the place where they make their catches, and a rough analysis of the fish caught at different places, do you think you could get trustworthy evidence from them on that?—Yes, I think you could get a certain amount of trustworthy information in the same way which would be useful as supplementary information.

2063. Supplementary to the statistical information of the fish landed at particular ports?—Yes. I have got that particular information with regard to pilchards and mackerel, and crabs and lobsters.

2064. Those would be the principal fisheries in Cornwall?—Yes.

2065. In your general view of the scheme for studying the sea, I see you propose that the local in-shore problems should be left to local authorities like the district fishery committees?—Yes.

2066. Do you think that a practical distinction can be made?—Yes.

2067. Of course apart from a case like crabs and lobsters—a distinction as regards fish?—I think there are very special questions which might come before a district authority, which they might wish to have investigated, and on which there would not be sufficient detailed information to be got from the results of systematic survey. Then, if they wanted the information it would be quite easy to arrange that they should carry it out themselves, or if they had not the money to carry it out they should make application to the central authority for assistance.

2068. Do you think the fishery committees are suitable people to do what we may call minor investigations within their own districts?—It depends. Many of them are scarcely sufficiently conversant with fishery matters to know what problem should be investigated, but when a question comes before them what they might do is to obtain the services of some expert who would carry out the investigation for them.

2069. The Cornish Committee apparently consults you?—It has done so, yes. That is an example. When there was a considerable agitation as to the size at which crabs should be limited by bye-law, which question was discussed in reference to their breeding, the Committee at once wanted to know what the truth of the matter was. They asked me about it, and I was able to give them a certain amount of information. But I was not in a position at the time to carry out careful investigation of the matter. In a case like that the Fisheries Committee might very well have appointed a man to carry out the investigation for six months or so, and to give them a report upon it. They did not do that to me; they simply asked me if I could tell them. They did not commission me to carry out any inquiries at all.

2070. However, you were available there, and you did advise them?—Yes, I advised them so far.

2071. Was that only with a view to a bye-law?—Yes.

2072. But then the result would be available for general information for other sea-fishery committees?—Scarcely, because the sizes at which crabs breed might be different in different districts.

2073. Was it not available in that case?—No, not generally.

2074. Passing to the question of the open sea, I see you recommend an international scheme of work, no doubt having in mind the North Sea?—I do not exactly recommend it. The international scheme has been elaborated by two conferences at which the Government of England has been represented, and I suggest that as all the other Governments have agreed to carry it out the first thing we should do in England, or that the Governments of England should do, is to express its willingness to join in the scheme.

2075. But, personally, you commend the scheme?—Yes.

2076. I notice that you say that the first work of the Scientific Fisheries Department would be to co-operate in carrying out the international exploration of the North Sea?—Yes.

2077. Leaving the south and west coast for later consideration?—Yes, unless it should be considered advisable to include the Channel in this international scheme. I see in the programme the English Channel is really included in the areas.

2078. A long way down the Channel, I take it. You consider the south coast of Cornwall was included in the scheme, and the north coast would not be?—Yes. One need not go quite so far as the Lizard. If one took the Channel as far as Plymouth it would be a long way. It is an interesting fact as regards the Channel that there is a very important connection between the Channel and the North Sea; conditions both physical and biological extend almost continuously from the Channel up through the south part of the North Sea, between Suffolk, Norfolk, and Holland, and all along the coast of Holland.

2079. Are you aware whether there is any scientific or practical problem nearly as important as that of the North Sea Fisheries, any problem affecting the Irish Sea for instance, or the west of Scotland, at all comparable in magnitude to it?—No, I do not think there is. I think that the method of, and the conclusions to be drawn from, an exhaustive examination of the North Sea would enable us to know what to do about the other parts, whereas if we were to attack them all at once we should want more money, and I do not think we could come to conclusions so quickly.

2080. Not only is it easier in itself, but it is likely to be very instructive as regards the others?—It is likely to be very fruitful, and also lighter, because we have already from preliminary investigations some information regarding the North Sea.

2081. It looks very large, but I gather in your opinion it is not quite so large as it looks, because a great deal of preliminary work has been done?—Yes.

2082. The sort of work you and Mr. Holt did for our country?—Yes.

2083. And the work which the Germans and Norwegians have done?—Yes. Of course they have done a great deal also with the physical part, with which I have nothing to do, as to the circulation of the waters and the origin of the waters—the change between Arctic and Atlantic water, which undoubtedly affects the distribution of the fish in a very important manner.

2084. As you are concerned with the whole of Cornwall, which has a fishing population on both coasts, are you aware of any very burning problem affecting the north side which requires scientific investigation?—I do not know whether you are alluding to any special thing?

2085. No, I am not?—The only interesting problem which I can think of just at present is the question of the alternation between pilchards and herrings on the north coast, especially at St. Ives. It is a thing I have been always very much interested in myself, but I have never been able in the conditions of my appointment to attempt to investigate it. It would be a rather large thing to undertake. I have tried to get a little evidence bearing upon it, but I am afraid not very successfully. It is a question whether the periods of the pilchard and herring fishery there are determined by physical conditions, and whether one could get at the reasons of that by a sufficiently extensive investigation. It is probable, or possible at all events, that the question of the circulation of water would have to be investigated by vessels at sea by taking the densities and temperatures and currents.

2086. It would be a problem affecting migratory fish which would probably be much more difficult to solve than one dealing with stationary fish?—Yes, I think one would come more easily to conclusions with regard to sole, plaice, and turbot.

2087. Also, when you found out the solution of your

puzzle about the pilchards and herrings it would not have very much practical bearing, would it?—It would enable the men to give up trying for herrings when pilchards would be more productive; it would prepare them to try for pilchards.

2088. But it is hardly conceivable, is it, that the causes which affect migratory fish like pilchards, herrings, and mackerel can be modified by human agency?—No, I do not think they can.

2089. Whereas it is quite conceivable that the causes which affect flat fish, for instance, could be modified by human agency?—But only the human causes.

2090. Only the human causes, yes. It is quite probable that the human causes which affect flat fish are important?—Quite so; I have not the least doubt about it with regard to soles, and turbot too, probably.

2091. The human causes affecting the herrings are generally believed to be insignificant?—They seem to be up to the present, because after a scarcity, when people may think the supply of herrings is diminishing there comes a year when they are more plentiful than ever.

2092. Huxley's theory that man is the least dangerous enemy of herring probably still holds good?—Yes, with regard to herrings, but we do not know how long it will do so when we consider the immense increase in captures, especially by the aid of steam.

2093. There is no doubt that man is only one among a great many enemies of the herring?—Certainly.

2094. There is some reason for believing that he may be the most important enemy of the sole?—Yes, certainly.

2095. (*Mr. Archer.*) I see you say it is not enough to know the quantity of fish landed unless we have the means of knowing how far old grounds are exhausted and new grounds exploited: how would you propose to get that information?—When I wrote that I was thinking that the information would be obtained by this systematic exploration of the fishing grounds.

2096. By special boats?—Yes, of course, to ascertain how far the supply of a particular ground is diminishing. Apart from the fishing boats themselves, or the market, one would want to compare one year with another. The mere statistical investigation for one year would not tell one whether the supply was increasing or not. If it were conducted for five years one would probably be able to tell whether it had diminished in that time.

2097. Do you think the information we should get from those special boats would be sufficient to enable us to say whether the fishing grounds were falling off or not?—Yes, for that period.

2098. You think that periodic trawls during a certain portion of the year by one boat on a particular ground would be comparable year by year?—Yes, but I would not say a certain portion of the year, because the ground should be visited at several times in the year. There is no doubt there are regular periods in the visits of fish to certain grounds. It would be necessary to take all the seasons for each year.

2099. But if a visit were paid in all the different seasons, then you consider the take of fish by that boat would give us information with regard to the fluctuations in the quantity of fish?—Yes, I think it would give very valuable information on that point, although of course I think if it were possible to get information of a commercial kind as well it would be very valuable.

2100. Do you not think that a disturbing factor would arise from the increase and decrease in the number of commercial trawlers fishing?—I do not quite understand you.

2101. The special boat is a unit. If she is one of a thousand, and the quantity of fish is limited, she presumably does not get the same proportion of the total take as if she is one of a hundred?—No, but if we consider how the boat gets fish at all, the amount that she gets on an average in trawling must be due to the distribution of the fish on the ground. I mean in this way. Suppose you start at the Dogger Bank at a certain period of the year, and it is abundantly stocked, whether one boat goes there or fifty for the first day they all get good shots. Perhaps at the end of three months fifty boats will have a decreased supply—the supply will be very much diminished. Whether fifty boats or a thousand, the catch of any one would show the supply on the ground. It would be diminished in three months to that extent due to the fishing. The question comes whether it would be permanent or not. Suppose they did not fish there till the same time next year, suppose the ground was lying fallow till the next season, if the boat went there in the following season and found the supply was as good as on the first day of the previous season you would see that there was no permanent diminution.

2102. But that is always presuming that certain grounds are only visited at certain seasons of the year, and that the season when the fish come on the ground is definately known and the voyage is made at that special season?—I do not think that presumption is entirely proved.

2103. I thought that was the presumption upon which you proceeded?—No; I have not proceeded upon that presumption.

2104. Then I misunderstood you, I am afraid. I understood you to say that on the first day you trawled over a particular bank whether you had one boat or a thousand, you would get a proportion of the fish which were there?—Yes.

2105. And it was not until you had been fishing on that bank for three months that that proportion would be diminished?—Yes.

2106. Is it the case that you do go to one particular bank at the commencement of each season, or do you fish more or less through the whole year in that way?—That is the point we want information about more than anything, to know what the regular periodical movements of the fishes are, and what they are regulated by, whether fish are feeding on a certain ground at a certain time of the year or whether, when they are in breeding condition they visit a certain other ground. We have certain information on the point in an indefinite sort of way, not very accurate. We know the fish do move frequently. I will take an obvious example I know myself, although I suppose fishermen would not all support me in the matter. I know that the common flounder lives merely either in shallow grounds or actually in fresh water during, say, nine months of the year, and in the breeding season it goes out as far as thirty or forty fathoms depth. There is no doubt about a case like that, but we have not definite information with regard to other fishes on other grounds, we want it very much.

2107. That is one point I wanted to ask you about. The only other point was with regard to your paper on the North Sea investigations to which you referred. Do you come to the same conclusions as Mr. Holt with regard to the size limit?—No. I do not know what Mr. Holt's conclusions may be now, but when Mr. Holt worked at Grimsby he reached certain conclusions which were perfectly true for the ground he investigated. I mean I do not doubt his conclusions so far as they go for that particular area. He proved that the plaice were mature between 13 and 17 inches, and he proposed very definitely before various committees that the size limit to be any good should be at least 13 inches. I came after him. I was working at Plymouth at the time, but not very largely, on that point, only to a certain extent, and afterwards I took up that special point in the North Sea, and showed that both on the Lowestoft grounds and the Plymouth grounds in the Channel the female plaice were mature between 9 inches and 13 inches instead of between 13 inches and 17 inches, roughly speaking. I argued very strongly, and I do now, that a limit of 13 inches would be utterly impracticable, and that if it were enforced it would almost extinguish the trawl fishery at Plymouth and Lowestoft, although it would be perfectly feasible for the grounds further north. Therefore I said if you were to apply a general limit, let it not be higher than ten inches.

2108. Did your investigations actually extend into the area that was spoken of this morning, east of longitude 7° 30′? I think it is, what they call the Bight of Heligoland, coming up *here (pointing to the map)*?—Yes.

2109. Did you get any large quantities of fish there?—There we mostly got small plaice—very few large ones.

2110. At what season of the year was it when you were in *this* part of the water (*pointing to the map*)?—I think it was in May.

2111. (*Chairman.*) Were the plaice undersized?—Yes, from five inches upwards. A large proportion of them were undersized. But with regard to the breeding size I worked at Grimsby and afterwards at Lowestoft, and for the determination of the sizes I collected large numbers, buying a trawl box at a time from different grounds, trying to make myself certain of the place they came from, that is to say, estimating the trustworthiness of the skipper's evidence. I think in most

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cases it was trustworthy. I had boxes from *here (pointing to the map)*, and further north than that, and when at Lowestoft boxes from *there* and *there*. I got all the sizes put down, and every fish was examined.

2112. Did you have boxes from *here*?—Yes, but at that time of the year there were no mature fish to be got; they were all immature.

2113. Was there a large number under eight inches *here*?—Yes, a large quantity. With regard to the sizes, would it be the wish of the Committee that I should send in copies of these papers with regard to the actual observations of fish on board the trawler?

2114. (*Mr. Spring-Rice.*) That is the Marine Biological Association's report?—Yes.

(*Chairman.*) We have them here. I do not think there is anything else I have to ask you.

NINTH DAY

Thursday, 23rd January, 1902.

PRESENT:

The Right Hon. Sir HERBERT MAXWELL, Bart., M.P. (*Chairman*).

WALTER E. ARCHER, Esq. | STEPHEN E. SPRING-RICE, Esq., C.B.

R. E. MARTYR, Esq., *Secretary*.

Captain T. H. TIZARD, R.N., C.B., F.R.S., called; and Examined.

Capt. T. H. Tizard, R.N. 23 Jan. 1902.

2115. (*Chairman.*) You are Assistant Hydrographer of the Admiralty?—I am.

2116. There are certain questions connected with the hydrographic survey of the North Sea which have been referred to us, and I think my friend Mr. Archer has given more attention to it than I have, and I will ask him to find out what you have to say?—Very well, sir.

2117. (*Mr. Archer.*) I think you have read the recommendations which were made at the Christianie Conference with regard to the hydrographic observations?—I have.

2118. And you will have seen there that it was proposed to collect information as to the physical conditions of the sea, the tides and currents, and the nature of the bottom?—Quite so.

2119. I would like first of all to ask you what you could tell us with regard to the proposed investigation of the physical conditions?—I have drawn out on a chart of the Admiralty the area depicted in the Christiania book proposed to be undertaken by this country. You see it goes from Loch Ryan out westward to deep water, and then to the Faroe Islands on the west, and from Whitby to Bergen, and from Bergen across to the Faroe Islands on the east and north. By this chart it will be seen at once that a great deal of the information that is required so far as depths are concerned has already been ascertained, and the depths will not alter. The depths west of Scotland have not been ascertained closely, but are sufficient to show that the water is deep—it is all over 100 fathoms.

2120. The lines indicated in this chart have been taken from the report of the Stockholm Conference?—Yes.

2121. I understand that the Christiania Conference did not attach particular importance to the actual lines laid down at the previous Conference, but that they considered it necessary that observations should be taken four times a year across the entrances to the North Sea?—Only the North Sea?

2122. What, apparently, they are particularly anxious for is a series of observations across the entrances to the North Sea?—What do they call the entrances to the North Sea?

2123. I take it that they would call the entrances to the North Sea a line somewhere from the North of Scotland or the Orkneys towards the Norwegian coast, a line across the Straits of Dover somewhere, and further a line to cut off the water coming from the Baltic into the North Sea?—Then they do not attach any importance I gather to the line west of Scotland?

2124. I believe they do attach importance to observations made in the Atlantic, but they attach primary importance to observations made to try and ascertain the condition of the water entering the North Sea?—Of course, that much simplifies the matter; that would be much more easily done than the others, because it is a very short distance from the Shetland Islands to the coast of Norway, or from the Orkney Islands to the coast of Norway, and, of course, it is a very short distance across the Channel.

2125. How far do you think that observations taken four times a year across the entrances to the North Sea would show the nature of the water going in and out?—I do not think that it would show it at all.

2126. You do not?—No, because it depends upon the wind at the time, and the sort of winter, and the sort of weather there has been preceding these observations. It would have a bearing only upon the condition at that particular moment. If you had a succession of northerly winds driving the water to the head of the North Sea it would be quite a different state of things to what would occur if a succession of southerly winds drove the water outwards. We know very well that northerly winds blowing down the North Sea to the Thames and so on raises the water 4 feet more than the ordinary spring rise.

2127. (*Chairman.*) What persistance of northerly wind would it take to accomplish that?—One single northerly gale would do it. With a northerly gale very frequently the water in the Thames is 4 feet higher than it ordinarily would be, whereas, with a southerly gale it is 4 feet lower. One cyclonic disturbance coming along the North West coast of Scotland, and ending in a fresh North West gale, would raise the level of all the water in the southern part of the North Sea.

2128. (*Mr. Archer.*) You consider, therefore, that it would be necessary to take observations at much more frequent intervals than four times a year?—Certainly.

2129. How often would you make those observations?—I do not think that you can draw any practical conclusion so far as the surface water is concerned in that way. The bottom water would be pretty much the same at all times of the year; there would not be much difference, it would depend upon the depth.

2130. You will have seen from the Christiania Report that it is proposed to take temperature observations, and samples of water at varying depths?—Certainly.

2131. They propose to select points along whatever line is laid down, and at those different points or stations to take observations at stated intervals of depth from the surface to 200 fathoms if the depth is so great. Do these observations to which you refer apply only to surface water, or to observations taken at intermediate depths?—The observations that I was referring to so far as the wind effect is concerned would principally be on the surface, but it would have, to a certain extent, an effect upon the under water in this way, that if you drive surface water into a bay and raise it up at one end it naturally flows out from underneath. Consequently, water that would be perhaps colder owing to rivers discharging into it might affect places where, ordinarily speaking, you would not expect to have such a result.

2132. Therefore, when you say you think observations taken once a quarter would not give any reliable results it does not only apply to the observations as to the

surface water, but also at lower depths?—That is in shallow seas such as the North Sea.

2132*. Could you define rather more clearly what you mean by shallow seas?—I should call a shallow sea a sea with less than 100 fathoms depth.

2133. To pursue that point a little further: Can you tell us at what depth the North Sea is influenced by the tidal currents?—That we have no decided experiments on, but it is probable that it goes down to a considerable depth. We know that in the Channel between Dover and Calais, where experiments have been obtained, it goes down to the bottom; but then the depth there is not very great—it is only 20 fathoms, or not more than 30 fathoms, at any rate. But in the other parts of the North Sea there is reason to believe that so far as tidal action is concerned the tide is more apparent near the shore than out in the open. Experiments, for instance, that were tried from a vessel by Captain Hewett, when he was in the East Coast survey—I am talking of 60 or 70 years ago—showed that there was a spot in the North Sea where there was no rise or fall of the tide.

2134. Would that indicate that the centre of the North Sea would not be much influenced by any tidal current?—Apparently not, but this is a theory which has to be decidedly proved.

2135. My point rather was that I believe a great portion of the North Sea is under 30 fathoms in depth?—A great part of it is.

2136. How far would the tidal currents in water of less than 30 fathoms influence the distribution of any water that might be coming in from outside the North Sea?—So far as we are aware, it would be only felt close to the shore, where we know what the rise and the fall of the tide is, and what the movement of the surface water is, but outside there is very little tidal stream, and of course it is much more difficult to ascertain what the actual rise and fall of the tide is out of sight of land, or to set up a tide pole, or anything of that sort; but on certain occasions this particular experiment was tried by Captain Hewett in an ingenious way, and he found no rise or fall of the tide in a particular place in the North Sea.

2137. Then to return to the subject of water entering the North Sea. How often do you think that those observations ought to be made in order to give reliable results?—That is a very difficult question to answer. I do not think myself that any such observations simply taken across the Channel between Dover and Calais, and between the Orkneys and Norway, could give you results from which you could draw conclusions as to the state of the water in the whole of the North Sea.

2138. Would you get any conclusions as to the state of the water going in and out?—You could only draw conclusions as to the state of the water going in at that time.

2139. And that time need not necessarily, and probably would not, give you a fair indication of the description of the water going in and out all through the year?—Certainly not.

2140. Supposing you were to repeat your observations at more frequent intervals, once a month, do you think that would be sufficient to give you an indication of the description of water going in and out?—Well, the more frequently they were repeated it would probably be better so far as drawing an inference in that way is concerned; but you must remember that the water in the North Sea is not derived entirely from the water that goes in and out from the ocean, but a great part of it comes from the land, from the discharge of all the rivers into it, and the condition of these rivers discharging the water into the North Sea would very much affect it. For instance, if a severe winter occurs on the Continent then large masses of ice are discharged into the North Sea, which would affect it very considerably. If there is a very mild winter, such as we have just now, then the water coming from the rivers into the North Sea would give quite a different temperature; at any rate, in studying this subject you cannot do so independently of climatic conditions, because the water discharged from the rivers would be quite different in temperature at different times.

2141. To pass on from the subject of the frequency of observations to that of the distance apart at which they should be made in order to give a fair indication of the description of the ground which intervenes between one station and another?—Well, that would be to a certain extent a matter of experience. If you take a place like the Channel between Dover and Calais they ought to be very close together—say three or four miles, but certainly not more than three or four miles, because we know that the water in the Channel is quite different upon one side to the other. The rapidity with which the stream runs is quite different on the French coast to what it is on the English coast. The tidal stream on the French coast is much faster than on our coast. But so far as the space between the Orkneys and the coast of Norway is concerned there is no reason to believe that there is much tidal stream across the whole of that space, and therefore a larger interval would probably suffice—say every twenty miles, but it would be only by experiment that that could be shown.

2142. Supposing that you were to have these observations—we will say at ten or fifteen miles apart, how long would it take a steamer to collect the information on such voyage?—Well, in this shallow water of course it would not take very long. I was contemplating this deep water to the west of Scotland, when it would take a considerable time.

2143. You think it would take a considerable time to get each separate observation there?—Yes. If you attempted to take it down to 1,200 or 1,300 fathoms—to take the temperature systematically and water samples, it would take a very considerable time, but if you are only taking observations by thermometer from 30 to 40 fathoms, it would take a very little time.

2144. (*Mr. Spring-Rice.*) Do you think you could do the Channel with six stations, say, in a day?—It would depend greatly upon the weather—whether it was fine, and it would depend upon the time of the year. In the summer time it could be done in a day certainly, because you would have daylight from four o'clock in the morning until eight o'clock at night. But if it were in the winter time, with thick weather, and with daylight only eight hours, then you might not be able to do it in a day.

2145. (*Mr. Archer.*) How long do you think taking the observations from the coast of Scotland to the coast of Norway would occupy?—I should think about two days would be sufficient to do that under ordinary circumstances, but in the winter time you may be kept very much longer than that. Bad weather, thick weather, or not being able to obtain any observations to check the ship's position.

2146. Within what interval of time should observations at different points be taken to be comparable one with the other?—You mean on these particular lines?

2147. I mean on these particular lines?—The distance between?

2148. No, the interval of time?—Providing they were done within a week they would be comparable.

2149. For instance, if observations were taken off the coast of Scotland on one day would they be comparable with observations taken off the coast of Norway a week later?—Provided there was no great change of weather in the interval. For instance, if you take the observations in one time after a southerly gale, and the other after a northerly gale, then they would not be comparable one with the other, because the conditions under which you take them would be quite different.

2150. Then in addition to ascertaining the water going in and out of the North Sea by these observations taken across fixed lines at the entrances they also proposed to take cross lines across the sea to ascertain the condition of the water in the sea itself?—At the same time?

2151. Presumably at the same time, or as near to the same time as possible to be comparable?—Well, in order to be comparable at all they ought to be at the same time.

2152. That is to say within a week?—Certainly; under ordinary calm conditions.

2153. Now, at what distance apart do you consider it would be necessary to place those lines in order to get a fair sample of the condition of the water in the sea?—That has not been considered by me. Those are questions that I have not looked at, because the paper that was given to me pointed out the particular lines that were required, and I have been studying those lines, and not lines across the North Sea.

2154. Do you think that without those cross lines any observations at the entrances would be of value?—I think they would be of value, but there is no doubt

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they would not tell the exact condition of the whole of the water in the North Sea. Those two cross lines would be quite clear of all the rivers discharging into the North Sea.

2155. Further, do you think that the water after it got into the North Sea might be liable to get mixed up; for instance the water coming from the Baltic with the water coming from the Atlantic or from other sources?—You first of all assume that there is water coming from the Baltic into the North Sea, and from the Atlantic into the North Sea. We know that the water that comes from the rivers goes into the North Sea, but the other part is hypothetical.

2156. You think that it is not yet proved?—I do not think that it is proved that there is a constant relationship between the North Sea and the Atlantic or the North Sea and the Baltic.

2157. (*Mr. Spring-Rice.*) That is what those observations were intended to endeavour to find out?—Yes.

2158 (*Mr. Archer.*) Do you think that those observations if made would show that?—Not merely the observations of the entrances.

2159. What observations in your opinion would be necessary to give that?—Well, a large number. I should think a considerable number of sectional lines taken across the North Sea at similar times as the observations taken at the entrances.

2160. What number of boats do you consider would be necessary to give that information?—There should at least be one vessel for every line. Of course, they should be got simultaneously.

2161. Can you say what number of lines would be necessary?—I have not studied it.

2162. You would not say whether it should be ten or one hundred?—I would not like to say at present without considering the subject.

2163. (*Chairman.*) Would you be prepared to submit a scheme of thorough examination of the hydrographic conditions of the North Sea in order to give the Committee some idea of the scope of the undertaking?—Yes, I could do that certainly.*

2164. Have you any further information as to the water on the West Coast?—I could show you what has been done there—the vessels that I have been in, and other vessels. For instance, there are two reports—I do not know whether you have had them before you—about investigations of the Faroe Channel, which are published in those reports. Sections have been made showing the conditions of the water in the Faroe Channel.

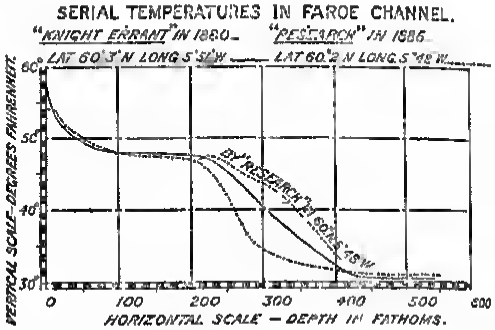
2165. (*Mr. Spring-Rice.*) These would be all available supposing any international scheme were taken up?—Certainly, they would be all available.

2166. (*Chairman.*) Observations of a single season?—Observations of a single season.

2167. I suppose the seasonal variation would not be as great in the deep water?—Practically speaking, in depths exceeding 100 fathoms there is no reason to believe that there is any variation in temperature.

2168 And such currents as exist would have a more normal character than currents in a shallow sea?—Certainly. Moreover, any current that exists in a depth exceeding 100 fathoms would be a very slow moving current. You could probably tell better by temperatures what was going on than by actual current observations except, of course, in places where submarine elevations separate closed areas. For instance, we know from experiment what the current does in the Straits of Gibraltar interchanging the waters of the Mediterranean with the Atlantic. Similarly we know that the Arctic Basin is separated from the Atlantic Basin by a submarine ridge; this separates the Arctic water from the Atlantic. There is a ridge that goes from Scotland to the Faroe Islands and to Iceland, and from there to Greenland, and that ridge separates the deep water of the Arctic basin from the deep water of the Atlantic basin. Over that ridge there is a small outflow at the bottom, which does not affect the Atlantic water very much, but still it does slightly. But at one side of this ridge you get bottom temperatures, say at 700 fathoms, of 45° Fahr., and the other side of the ridge at the same depth you get 30° Fahr.

2169. And that is pretty constant?—That is constant. On this chart I have drawn out a little curve, which shows that constant temperature. One was a curve taken in 1880, and the other is the curve that was taken very many years afterwards in the "Research." It is only where the waters interchange that there is any slight difference, but down at the bottom the water is the same, and up at the surface, and down to a certain depth it is the same.



2170. But the conditions in the North Sea would be very much more variable?—Very much more variable.

2171. And would require more extended observations to verify?—Oh, certainly.

2172. (*Mr. Archer.*) For instance, we were told that the further from the land the more uniform the conditions, but I suppose that would not be so applicable in the North Sea as it would be in the deeper waters in the Atlantic?—No, not in the shallow water. It is not the question of the North Sea, but the question of the shallow water. In the deep water on the coast of Norway probably the conditions are the same all the year round, but in the depths of 50 fathoms the conditions are probably not the same.

2173. There is hardly a greater depth than 50 fathoms anywhere in the North Sea south of latitude 58?—There are areas with depths exceeding that. For instance, there is a ditch off the coast of Norway that has a greater depth than that, and there are one or two other ditches. There is a ditch down by Buchan Ness, called the Buchan Deep, which is over 60 fathoms.

2173*. There is the North Sea chart; what does this line represent (*pointing*)?—That represents the contour line of 50 fathoms, and that represents the contour line of 100 fathoms in the North Sea.

2174. Is it not then the case that practically the whole of the North Sea south of 57½° is under 50 fathoms—practically the whole?—Practically the whole.

2175. The next point on which they propose to collect information is with regard to tidal currents; you probably noticed that?—Yes.

2176. At what distance apart should those be taken to be of value?—Well, so far as the entrance to the Channel is concerned, we have already got those between Dover and Calais. We have got some observations there which I think are practically all that is required, but I should say that in the North Sea about, say, thirty miles would be sufficient to take tidal observations.

2177. Along one line?—Along one line.

2178. Across the entrance?—Across the entrance; but it is a difficult operation, you must anchor your vessel to do it.

2179. How long would you have to have your vessel anchored?—Certainly for twelve hours.

2180. (*Mr. Spring-Rice.*) For tidal observations?—Yes.

2181. (*Mr. Archer.*) Could you take a series of tidal observations from the Scottish to the Norwegian coast?

* *See* Appendix V.

—You could in fine weather, but it must be remarkably fine weather.

2182. At what depth could you anchor?—You could anchor in any depth across there.

2183. Even in the deep water off the Norwegian coast?—Yes, with proper wire hawsers. When I say twelve hours that is the shortest possible time in which you can get observations.

2184. Each observation?—Each set of observations.

2185. That is each set of observations at each station?—Yes, if you want to get observations right down to the bottom at different depths it would take very much longer than 12 hours—it would require that for surface observations.

2186. And it could only be done in very fine weather?—Yes.

2187. With regard to bottom deposits; at that distance apart ought these to be taken?—That I am not prepared to say; it depends upon other people to settle that part of the business. Deposits at the bottom may be so extraordinarily different at different places. I will give you an instance of that. In 1868, when the first deep sea exploration took place westward of Scotland, they found a remarkable locality where there were any amount of sponges, and a large number were dredged up. We went there afterwards in 1882 and in 1880, and only found one, although it was exactly in the same place so far as we knew. It shows that although these sponges were dredged up we did not hit the particular area in which they existed.

2188. I suppose the bottom observation taken once is good for all time?—Over 100 fathoms—the depth over 100 fathoms. You mean the observations of the bottom?

2189. Yes?—Yes, certainly.

2190. What is known at present with regard to the bottom of the North Sea?—The bottom has been ascertained, so far as the immediate surface is concerned, by the arming of the lead wherever soundings have been taken. But the arming of the lead and the material brought up by that does not necessarily give you what the bottom is. The only way you can get that is to bring up a specimen either by a dredge or by your anchor. For instance, in the great part of the North Sea you will find the lead will bring up a sand with the ordinary arming of the lead, but if you anchor there you perhaps bring up a large lump of clay from the North Sea with a bit of surface sand on it. When I was surveying the North Sea I made a collection of those brought up, and they were all sent to Sir Archibald Geikie, and they are now in the Geological Museum.

2191. Have we any records of what has been brought up by the dredge?—Certainly, they are in Jermyn Street.

2192. To what expanse of the North Sea do those extend?—They are not very numerous. There are some specimens sufficient to show that the lead does not necessarily tell you what the bottom is.

2193. But not sufficient to show what the bottom really is?—Not sufficient to show what the bottom really is.

2194. (*Mr. Spring-Rice.*) From the point of view of a geologist, a knowledge of the superficial deposit is of little importance to the seaman and fisherman, I take it. The important thing to him is what the rock underlying the bottom is?—It is to this extent, that that is the way that he gets the bottom, and of course when determining his position at sea he wants to know what the lead will bring up. But that is from a nautical point of view. Whether this is sufficient to know whether fish will go to a place with sand on it, whether that sand is merely covering a bed of clay or thick sand down at the bottom, is quite another thing.

2195. The practical man would do that?—That is what they do practically, no doubt.

2196. (*Mr. Archer.*) For biological purposes would it be sufficient to know what the lead brought up?—I cannot answer that. I do not profess to be a biologist.

2197. Are you acquainted with the investigations of the Marine Biological Association in Plymouth Bay?—I have seen some papers in connection with them.

2198. There they have divided the material brought up from the bottom into different grades, and in a distance of some 26 miles they have laid down, I think, 13 different grounds?—I should think that is very probable off Plymouth, because it is on rocky ground.

2199. They found it possible to group together many of the hauls which showed a similar fauna and bottom deposit. Eighteen different grounds were recognised in that short space. How far would that be applicable to the North Sea?—Well, that is an impossible question to answer.

2200. You could not say?—I could not say. What I do say is this, that if there are such great differences it would be much more difficult to ascertain their exact localities in the North Sea than off Plymouth, where the land is high, and where you can fix your position by the shore; but in the North Sea, out of sight of land and, moreover, where the land is principally low, you would have to trust to astronomical observations, which cannot always be got.

2201. I was not referring to the nature of the bottom as showing your position, but rather to the number of observations which it would be necessary to take in order to ascertain the nature of the bottom deposits over the North Sea affecting the distribution of fish?—I think it would be requisite to have an enormous number.

2202. And the information we have at present would not help us very much?—Well, that I cannot say.

2203. There is another point: Supposing that certain stations were fixed at different parts of the sea where the periodical observations were to be taken, possibly out of sight of land, how near would it be possible to come to those stations?—Well, you could not hit off those particular stations under any circumstances unless in fine, clear weather, when you could see the astronomical bodies—the heavenly bodies; it is impossible to say what the current would be anywhere when the current is so much influenced by wind that has been prevailing.

2204. And therefore, in the winter time it would be very difficult to hit off those stations?—Certainly. Probably in the month of November, when the fogs are all over the North Sea, you could not hit them off at all—not accurately.

2205. And if you can take the position of the astronomical bodies, could you hit them off then?—Very closely.

2206. Within what distance?—Within a mile.

2207. Otherwise you could not be sure of going within what distances?—Not within twenty miles; perhaps more.

2208. (*Mr. Spring-Rice.*) When you were surveying the North Sea personally, you frequently came in contact with fishermen, did you not?—Very frequently.

2209. And I have no doubt you did your best to get information that would be useful to them?—Certainly.

2210. The whole question that we are discussing is primarily information for fishing?—Yes.

2211. I should like to ask you whether you think that you have got already a good deal of such information as practical fishermen require—whether it is on the charts or elsewhere?—So far as the fishermen are concerned I can only tell you that they used to ask me for information, especially at Grimsby; and I recommended one of the men there to go over to the west coast of Scotland on the Stanton Bank, and I believe that he went over there and fished for a considerable number of years; and he wrote me that he had worked it out and wanted to know where he was to go next.

2212. An extremely intelligent representative of the fishing interest has told us that he hopes, if he gets time, to work out to his own satisfaction a fishing chart of the North Sea—he called it a modal, but at any rate it was some sort of representation of the North Sea for fishing purposes, showing substantially the depths and the nature of the bottom with sufficient accuracy for fishing purposes all over it?—Yes.

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2213. I daresay your experience will enable you to appreciate what that means much better than I can?—Such a chart is, I believe, already in existence; it is published by a man at Grimsby, of the name of Olsen

2214. It must be something better than that. Do you think that the information that exists in the Olsen map is as accurate as the fishermen desire?—They have never told me that; I cannot say—I have not asked them. But I know that they take this map and use it.

2215. What I was coming to rather is that this formidable statement about a survey of the bottom of the North Sea is not, when you come to close quarters, so formidable as it looks, because most of the work has already been done?—Certainly the surface depths; whether that is what the biologists mean I cannot say.

2216. That part of the programme is not a biological part; it is only hydrographical or physical, but you are inclined to think that a great deal is known about the surface of the bottom of the North Sea?—Oh, yes.

2217. Have you read any of the literature, which I think is rather extensive, on which the scientific and practical men who assembled at Stockholm and Christiania based their ideas as to what ought to be done?—No, I have not read that.

2218. (*Mr. Archer.*) Are you acquainted with the result of the Ingolf expedition?—At Iceland?

2219. In the seas off Iceland and Faröe?—I have seen some of the reports of that expedition, not all of them, but some of them.

2220. And the "Pomerania" expedition?—I think I have seen something about the "Pomerania" expedition, but I am not quite certain. I have got it in my mind—is it not something about the herring fishing principally?

2221. That is what I want to get information about?—I think there is something about the herring fishing in the "Pomerania" report. But the Ingolf expedition I have seen—the Iceland report. We look upon this with regard to hydrographic knowledge and not fishing knowledge.

2222. Have you seen this map appended to the report of the work of the "Michel Sars"?—Yes, I have seen that.

2223. Could you tell us at all how those colours are arrived at (*exhibiting the coloured map*)?—Those colours are arrived at not entirely from the work of the "Michel Sars," but from some observations that were taken by Professor Mohn, who made a remarkable survey of this part of the sea, and he wrote a long account of it.

2224. There is no indication given there in the footnote that that is the case?—No.

2225. Would a scientific man borrow from another without indicating the source from which his information is taken?—He ought not to do it. But in this illustration they may have taken it for granted that those depths existed in that locality.

2226. Then, again, are you acquainted with this map which was appended to a short report by Messrs. Pettersson and Ekman?—Yes, I have seen that.

2227. You will see that a greater number of observations were apparently taken by them than by Dr. Hjort, and that greater variations in the salinity are shown. For instance, in December, 1896, there appears to have been an outcrop of water of greater salinity off Hausholmen?—Yes, you see you cannot reason this, because you do not know what the state of the weather was. If you got close to the coast, the wind blowing off the coast and blowing the surface water away, the water underneath would then rise up. For instance, along the west coast of Africa and the west coast of America there is no coral, because of the cold water which prevents it growing.

2228. (*Chairman.*) That would increase the salinity?—Yes, by the surface water being blown away and the heavier water underneath rising up to replace it, it would increase the salinity in that particular part. I cannot say that that was the case, but if there was a strong easterly wind blowing it would have that effect.

2229. (*Mr. Spring-Rice.*) No doubt anybody discussing observations of that water would take into account the prevailing wind?—Yes, and in shallow waters especially, and in all large localities such as this there are winds constantly blowing—in the west coast of South Africa and the west coast of South America, where the water is always cold along those coasts.

2230. That would be almost a commonplace to those who went into the subject at all seriously?—Certainly.

Dr. J. T. Jenkins, D.Sc., Ph.D., called; and Examined.

Dr. J. T. Jenkins

2231. (*Chairman.*) You are Lecturer in Biology in the Hartley College, Southampton?—Yes.

2232. You are familiar, I suppose, with the objects of our inquiry?—Yes.

2233. Have you any suggestions or observations to make with regard to them?—The German nation, or rather the Kingdom of Prussia, has for the past 30 years subsidised scientific investigation, not particularly with regard to problems which affect fisheries, but with regard to all problems both physical and biological connected with the seas, and more particularly with the German seas.

2234. You mean subsidised research to a greater extent than is subsidised in this country?—I am not acquainted with the amounts spent in England, but I can give you the figures with regard to the Prussian Commission, and you might be able to compare them. If you like I can give you them now. The expenses of the German Commission have been and still are borne entirely by the Prussian Government. The annual grant is £7,500—that is on the assumption that 20 marks are equal to a pound. I can give you the figures in marks if you prefer them.

2235. It is near enough—it does not matter.—This money is granted to the Prussian Royal Commission for investigation connected with the seas. In addition, Germany spends a great deal of money on sea investigations—that is to say, at various times they have made special grants for special researches.

2236. How long do you say this Commission has been established?—This last 30 years; it was established in 1870.

2237. And what has it got to show? What are the results attained?—The results are fairly considerable. I can give you a brief summary; in the first place, a special investigation was made in the North and Baltic Seas. This investigation was made on His Imperial Majesty's ship the "Pomerania."

2238. (*Mr. Spring-Rice.*) When you say the North Sea do you mean what we call the North Sea, or what the Germans call the North Sea. They call our North Sea the Westmeer, do they not?—Not in the Commission reports, I think. The Germans commonly speak of the North Sea as the West Sea, but as far as I remember in the reports of the Commission it is referred to as the North Sea.

2239. It means our North Sea?—Yes. For instance, in the journey taken by Apstein in 1895 the vessel started from Hamburg, sailed right across to the Norwegian coast, and then crossed the North Sea to the neighbourhood of the Scottish coast, and then took a bee-line more or less back to Hamburg, and during the whole of this journey observations were made both on the sea bottom and plankton observations with the Hensen vertical net. I think there is no difference between the English and German meaning of the North Sea.

2240. It is commonly called in German the Westmeer? But it is always called the North Sea in the reports. For instance, in the paper published by Hensen and Apstein in their official journal they refer to the North Sea—Die Nord-see-Expedition. I never saw the word "west," and I have read a great many of these reports. Well, the first thing they did was to undertake this preliminary investigation. They took samples of the sea bottom and investigated it both microscopically and chemically, and they made a number of charts which are still in use at the present day. They also inspected the fish markets—this was in 1873-75—and at this time a series of statistical observations on the amount of fish captured by German fishermen were commenced. These results were entered daily in a form, a specimen of which I have here with me—(*handing in same*)*—and which explains itself. The Germans believe that we

* See Appendix VI.

can only get correct statistics by entering the amount of fish caught in commercial trawling and commercial fishing, and not by just sending out a steamer occasionally, and making experimental hauls. They do not place any faith in that method of accumulating statistics. From what I have seen in England I should say that the German method was preferable—undoubtedly preferable.

2241. (*Chairman.*) That implies an absolute faith in the information supplied by fishermen?—Well, the information supplied by fishermen must be taken to be a minimum, they never give you a greater quantity of fish than they actually land. For very obvious reasons: You see they go to a certain ground and catch so many fish, and they never exaggerate that because it would attract other fishermen.

2242. What I refer to chiefly will be the information as to the locality. Supposing a fisherman were to bring in a good catch, and he had to enter upon that form the precise locality where it was taken, would it be always apparent to his interest to indicate the exact spot?—Well, within certain limits, of course.

2243. Limits of what—of truth or accuracy?—You see these particular forms are used on the Baltic, where there is very little steam used in fishing at present, and one can tell with a fair amount of accuracy where the fishing has been carried on.

2244. I will take an imaginary case of a trawler who had fished illegally, let us say, in the enclosed water of the Moray Firth, and had made a good haul there, and landed his fish at Aberdeen, and had to enter upon a form where that fish had been taken; would it not be very misleading if he stated that it had been taken at a part outside the enclosed limit?—Yes, it would, of course. That is a special case. Of course one cannot place too much reliance upon fishermen, they must be looked after.

2245. I do not want to labour that too much. You think, on the whole, that it is better to rely on statistics supplied by fishermen than by official experimental trial?—Yes, I think so, I certainly think so.

2246. Then the German Royal Commission has undertaken a census of the seas, has it not?—Yes.

2247. I should ask first, by what method?—In the first place with regard to animals of economic importance, for instance, fish, an attempt has been made by Hensen to estimate the number of fish in a given area, and not only that but the relationship of the number of adult fish in a given area to the number actually landed. For this purpose a special kind of net was devised, called the Hensen vertical net. You probably have seen figures of the net—(*handing in the same.*)—which fishes not in the ordinary manner but in a vertical direction, and a given quantity of water is fished through. The diameter of the mouth of the net is known; the depth to which it is sunk is also known, and the filtration capacity of the net substance is calculated, and then we can get an idea—a very fair idea—of the amount of water that passes through the net. Then the planktonic organisms, animals and plants, are retained in the net, and their number is estimated, not only fish eggs, but the number of microscopic animals and plants which do not seem to have any economic importance. I might quote one sample of such a series of observations; there are quite a number of these. It is quite impossible in one afternoon to give any idea of the extraordinary amount of work which has been put into this scheme. The first results of the Hensen method for fish eggs, at any rate, were obtained in the West Baltic, in an area of the sea just off a little village a few miles distant from Kiel, and the fishing that is carried on at this port is practically confined to an area of 16 square miles, just outside the harbour of Eckenforde.

2248. Where is that place you mentioned?—It is a small village near Kiel; 120 observations were made during the months from January to April. In January an average of 30, in February from 45 to 50, in March at least 50, and in April 50 floating eggs of cod and flat fish were obtained per square metre of surface. These eggs took on the average fifteen days to develop under the conditions obtaining in the West Baltic, so that the number must be doubled in order to give the total per month per square metre of surface water. This gives us a total of 370 eggs of cod and plaice from January to April. From the statistics accumulated over a period of nine years and recorded in similar forms to the one I submitted, Hensen calculated that the fish actually landed would, if they had been allowed to remain in the sea, have given a total of 110·6 eggs per square metre of surface water.

2249. I do not understand. You mean if the original eggs had been hatched and come to maturity?—No, I do not mean that. I mean the eggs destroyed in fish caught by the fishermen.

2250. What do you allude to by these fish?—You see the Germans calculated statistics for nine years on these forms. Now the annual average was calculated for the nine years for the adult fish landed. If these fish had been left in the water they would have given 110 eggs per square metre in addition to the 370 that were found. That can be calculated because the number of eggs yielded by mature cod or plaice can be calculated within reasonable limits, and the ratio of adult males to females.

2251. That is assuming that the eggs were laid in the same area that the fish were caught?—Yes.

2252. That is not always the case with the pelagic eggs; they are subject to currents?—They are subject to currents. Hensen emphasizes that, and he says that these results must be regarded in all cases as being a minimum, because it happens in certain years that the eggs are very much below the average. I come to that directly. If you add the number of eggs that would have been produced to the number actually found, you get a total of 480 eggs per square metre. From this you can calculate the ratio of cod and plaice actually captured to the number of cod and plaice in the sea. It is about one-fourth—110·6 upon 480·6 gives ¼, so that man captures about one-fourth of the adult fish in this particular area of the West Baltic. This is quite a confined area, and it is a special case, but it shows how the result is worked out.

2253. Is there any evidence to show that that rate of destruction has caused depletion of the fish?—Germans have come to the opinion that there is no such thing as over-fishing; that is the concensus of opinion of German experts at the present time.

2254. (*Mr. Spring-Rice.*) Do you mean that over-fishing is theoratically impossible, or that within the regions examined it has not, as a matter of fact, occurred?—They do not say that over-fishing is impossible. They cannot say that, but they say that the evidence that they have accumulated shows that there has been as yet no over-fishing.

2255. Within the regions that they have observed?—Yes.

2256. You would not put it higher than that yourself?—No.

2257. (*Mr. Archer.*) With regard to the calculation, is that made on the assumption that the eggs are distributed evenly over the whole area?—Yes, it is. The Germans differ from English expert opinion on that point. Professor Herdman at any rate marks out in the Irish Sea definite areas which he calls spawning areas. If you get one of Professor Herdman's maps of the Irish Sea you will see that he marks definite spawning places. Now, the Germans have come to the conclusion that there are no definite spawning places; that eggs are evenly distributed over the surface of the North Sea. I will give you, if you like, the facts and figures that have enabled them to come to this conclusion.

2258. (*Mr. Spring-Rice.*) There again you, speaking for yourself, would say that the conclusion the Germans have come to must be limited to the area within which they have made observations?—Yes, but that area is a fairly big one; it includes the whole of the West Baltic and the entire North Sea. That is a fairly considerable area.

2259. Speaking as a scientific man, you will probably admit that to generalise and make an absolute proposition like that is a very bold step, if they do so?—Well, I will give you an idea of the results obtained.

2260. Excuse me, that is not quite the point. You say they have made observations all over the North Sea and the Baltic. By that you mean at certain places in various parts of the North Sea and the Baltic?—Yes.

2261. No man, or no number of men, pretend yet to have taken observations all over the North Sea, do they?—No. Of course, we cannot be perfect in this kind of work.

2262. I am the last person to suggest that to you, but putting it as a logical proposition you must look very carefully at the facts, and at the observations on which these conclusions are based?—Yes.

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2263. When you say they have made observations all over the North Sea and the Baltic, I suggest that what is meant is that they have made observations at certain points in the North Sea and the Baltic, and they are assuming tacitly or otherwise that these circumstances are fair samples of the whole of the North Sea and Baltic?—Yes, and with justice.

2264. You are inclined to think that they are right in assuming that the samples of the North Sea fairly represent the whole of the North Sea?—Yes, and I will give you my reasons.

2265. But on the other hand, assuming that they are justified in generalizing from the North Sea, is that sufficient to upset Professor Herdman's views about the Irish Sea, with which he is, perhaps, as well acquainted as they are with the North Sea?—You see Professor Herdman has not made any quantitative observations. Now, the Germans have done this, and done it fairly completely.

2266. When you say this is a question of quantitative fishing, surely Professor Herdman's view, which is held by many other scientific and practical men, is based on observation, that he finds in certain parts of the sea fry or eggs, and in other parts he does not find them. Perhaps a fairer case is what he calls nurseries (I wish Professor Herdman were here to speak for himself). He contends that there are not only spawning places but what he calls nurseries?—The Germans do not go against the idea of nurseries, but they have a decided objection to a spawning place.

2267. Their experience does not go in that direction?—I give you the case of a steamer. A number of journeys were made in 1893 by Apstein, under the direction of Hensen. They started from Hamburg, and they made three separate journeys. As I said before, they started from Hamburg, and crossed to the Norwegian coast, and then went from there to Scotland, and came back in a more or less straight line. If you get the Commission reports you will find each spot is definitely marked out. That is, however, an approximate idea.

2268. (*Mr. Archer.*) Can you give us a reference as to where that is to be found?—Hensen and Apstein, Die Nord-See Expedition 1895 des deutschen Seefischerei-Vereins, Wissenchaftl Meeresunterauch. Bd. 2, Heft 2, Kiel, 1897.

2269. (*Mr. Spring-Rice.*) It is at page 341 in your paper, No. 6?—Yes. There is an error there; it is put down as Kiel, 1887; it ought to be 1897, I think. I will give you an idea of what they did. They made three journeys—the first journey in February; it lasted eight days. They covered 1,029 sea miles, and they made 53 catches; 49 of these yielded 1,932 eggs and larvæ; that is to say very soon after going out of Hamburg they started with the vertical net, and they made 53 observations, and in 49 cases they got eggs and larvæ. They got as a rule a small number, say 20 eggs, per square metre surface, but very often they got over 100 eggs per square metre of surface.

2270. Then the different catches averaged from 20 to 100—I mean proportionately?—Yes, proportionately.

2271. And 4 out of 53 were blank?—Yes, but this was early in the spawning season.

2272. (*Chairman.*) Now will you go to the second journey?—In the second journey they took very much the same journey in February and March. It lasted nine days—51 observations. In 50 cases they got eggs and larvæ. They got 6,678 eggs and larvæ. You see it is an enormous difference—in fact in a fewer number of observations.

2273. (*Mr. Archer.*) What was the limit of variation in that case?—The three taken together was 35 to 100 per square metre of surface. The third journey was in April, and they took very much the same direction; it lasted eight days. They made 58 catches, and in all cases they got eggs and larvæ. They got 6,975 eggs and larvæ of fish. In the estimation of this there was an enormous amount of work. It takes a considerable time to identify one sometimes. From this they came to the conclusion that there were no definite spawning places.

2274. (*Mr. Spring-Rice.*) May I ask have you seen any map or document showing how the catches were distributed—I mean out of the 50 catches which ranged from 20 to 100, do you happen to know whether there was a region where there were only 20 or thereabouts, or a region where they were mostly high figures?—Yes, if you consult this paper. I am sorry that I did not bring it—if you consult this paper you will find that not only is every spot marked on the map, but they have exhibited it a graphic manner by means of curves the variation in the number of eggs and larvæ. You get coloured curves, which show you exactly the number of eggs and larvæ taken in that particular spot. This is a very conclusive thing.

2275. (*Mr. Archer.*) As to the variation of the numbers taken, I see in the same paper, the last paragraph of the page immediately before it rather, that you stated in one specially exceptional case they got over 5,000 floating eggs per square metre?—That was on a different trip in the Baltic in the Skagerrack. I think, myself, that the explanation is that there must have been winds blowing from the east for some time previous to this, and that the Baltic water had become banked up in the neighbourhood of the Skagerrack.

2276 (*Chairman.*) How do these conclusions affect the fish hatchery question?—Well, the conclusion of the German authorities is that sea-fish hatcheries are a waste of money. Those are the very words of Hensen. I can give you the reference. Hensen says in the second volume of "Wissenchaftliche Meeresuntersuchungen" at the end, page 71, that in reference to the question of plaice eggs in the North Sea, "a falling off in the quantity of plaice captured in the North Sea appears to be satisfactorily established. It remains to consider whether this decline can be remedied by sea-fish hatcheries."

2277. He admits a degree of depletion?—Yes, in regard to flat fish he does definitely admit it. But they are coming round to the other opinion. This was written of course some years ago.

2278. That there is no depletion?—That there is no depletion. Hensen then goes on to say that his estimate of 15 billion eggs and larvæ for the North Sea may be too large, but with just as much probability it can be regarded as too small. The estimate of the North Sea with regard to plaice eggs is 15 billion eggs and larvæ.

2279. Fifteen billion in the whole North Sea?—This is for the whole North Sea. Then he says: "It is impossible to add one-fifth of this number yearly to the North Sea by means of artificial production. To add less than one-fifth of this number yearly to the sea is certainly a waste of money." That is not my opinion, but the opinion of Professor Hensen, who is, perhaps, the greatest authority on sea-fishery matters.

2280. That is assuming that his calculation is correct, and also assuming that the young fish are turned out in a larval condition as soon as they are hatched?—Yes.

2281. There is no means of doing more than that?—There is no means of keeping them beyond that stage at present. You would require to turn out three million times a million young fish, and the numbers actually turned out in this country are very much below that. I have never been to the Scottish hatchery, but in the case of the Lancashire hatchery they turned out from 15 to 20 millions of larvæ. There may be more at the present time. It is two or three years since I was there. The German authorities and the Director of Heligoland Biological Station are equally strong against sea-fish hatcheries.

2282 Have they considered the question how far reproduction may be assisted by treating spawn of fish taken at sea and fertilising it?—Yes, they have considered that. But does it not strike anyone that it is absurd to interfere with the fish in the natural condition? For instance, I was out one time in the Irish Sea on the Lancashire Sea Fishery steamer; we fished for haddock and cod. We caught about 100 spawning haddock, and, perhaps, from ten to fifteen big cod; the cod were all male. We could not get any eggs; we killed from ten to fifteen big fish with no result. In the case of the haddock we did get some eggs; the net was brought up at midnight, and the fish were more or less dead, and there was a tremendous lot of dirt in the net. In many cases the intestines were protruding, and we got a lot of eggs for fertilising, and they were nearly all dead next morning.

2283. The eggs were dead?—Yes, so that we destroyed at a low estimate, say 120 spawning fish—there were other kinds as well—with no result. Now the total number of eggs planted from a hatchery of that kind in one year would not equal the product of 120 fish if they were allowed to spawn in a natural condition.

2284. I am not talking of them only from the hatchery?—We interfered with the fish in their natural condition, and attempted to take eggs from them, and

attempted to take them to a hatchery, and put the young back to the sea.

2285. That is my point. As I understand, the suggestion has been made that eggs might be fertilised and set adrift into the sea?—That would be a better plan, of course; there is no reason why that could not be done.

2286. It involves a great deal of trouble?—Not so very much. The difficulty is to make the trawlers understand that it is to their interest to do this—it would not be very much trouble.

2287. It is not a nice job?—It is not a nice job, but of course trawling is rough work anyhow.

2288. My original question was: Has the attention of the German Commission been addressed to that point?—Yes.

2289. Have they made any recommendation upon it?—Not in a published work, but from conversations which I have had with Professor Brandt, I should be inclined to think that their opinion was dead against sea-fishery hatcheries, and against the method of taking spawning fish out of the sea and putting the eggs back.

2290. But you always evade my point—I want to keep you at sea?—I do not know that I have spoken to them about that point. Do you not see that these fish would be caught in one case by commercial trawlers? You might save those eggs; but this was a special expedition to take the fish from their natural conditions, which is quite a different thing. This was not a commercial scheme at all. Of course my opinion is not worth very much perhaps.

2291. (*Mr. Spring-Rice.*) What was in the Chairman's mind was this, and I put it to you as a question: Have the Germans ever considered it would be worth while encouraging trawlers who are catching fish for commercial purposes to put back the spawn into the sea?—I could not give you any information upon that point, I am afraid. But they are dead against sea-fish hatcheries.

2292. (*Chairman.*) On the other hand is it not the case that the fresh-water hatcheries have been largely developed in Germany?—Yes, that is quite a different thing.

2293. You have some reasons, I understand, for advocating a similar expenditure in this country to that which has been undertaken in Germany. What good results do you anticipate—why, in short, should not we let the Germans go on solving these problems for us?—Well, it is a question of national pride, more or less, I take it. It is rather galling that a man has to go to Germany to complete his education, and that he is forced to adopt German opinions, and to reject the opinions of his own countrymen.

2294. There is no nationality in science?—There is none, of course. Now, the German Government advertised the other day for assistants for sea-fishery work. If one thought of going and becoming a German citizen, one would find that there is a certain amount of nationality then. One does not give up one's nationality for nothing. They still want these men, and they cannot get them; and they are advertising for assistants, and the difficulty is to get them.

2295. It would involve a certain amount of over-lapping, would it not?—I do not think so.

2296. Not if the English Commission and the German Commission were investigating the same areas simultaneously?—But then this international scheme is so drawn up as to avoid that, is it not?

2297. That is another question?—Each country will undertake the investigation of a separate portion.

2298. I see you advocate a national investigation: I had overlooked that?—The Germans are committed to this, and I can give you figures of the expenditure and so on.

2299. (*Mr. Spring-Rice.*) May I ask whether you know what view Professor Hensen and his Prussian colleagues entertain upon the question whether anything can be done to check the decrease of fish, especially flat fish, by protecting certain areas not as sources of spawning, but as what some people call nurseries?—The German opinion at present is that there is no need for anything of that kind.

2300. But you said that Professor Hensen had expressed a view that there was undoubtedly a decrease?—That is expressed with regard to one single fish, and it was expressed some years ago. But at present the Germans regard the sea as inexhaustible, and that was the opinion of Professor Huxley as well.

2301. He is often quoted on that, but I think it was primarily with reference to the herring?—Yes.

2302. And the subject which is most prominently before public men in England and Scotland is not the herring, but the flat fish. Now, I have no doubt you will agree that the conditions under which flat fish exist are so extremely different from those of the herring that what is true of the herring is very likely untrue of flat fish?—Yes, but these nurseries of flat fish are almost invariably within the three-mile limit.

2303. Is that your own opinion?—That is my opinion; at any rate as far as the Irish Sea goes that is definitely settled.

2304. Of course, you are aware that a great number of people of practical experience do think that there is a decrease in the yield of flat fish, especially within certain areas. You think the Germans deny that decrease?—Yes.

2305. Do they deny it on the basis of statistics that they collected themselves?—Yes.

2306. Do you consider that the statistics which they have collected about the yield of flat fish from the North Sea are comparable in statistical importance to the information that is at the disposal of the Grimsby fishing trade?—It is quite possible that their statistics may be more carefully collected, but with regard to the quantity of information, no—— There is not the slightest doubt that Grimsby is ahead of Germany in that respect.

2307. You have quoted the Germans as saying that the practical experience of commercial fishermen is the solid basis of statistics rather than occasional experimental trips?—Yes.

2308. So that it is not derogating from their scientific weight to suggest that an opinion which is held, we may say, unanimously, by the fishing trade of Grimsby, with its enormous business, and about a district where their daily avocation lies, is entitled to a great deal of weight. Do you think that Professor Hensen would dissent from that?—I do not think so.

2309. Do you know whether the Germans who formed that opinion have visited the place where the largest fisheries are carried on, and tried to ascertain for themselves what is thought there?—Oh, yes; they got access to these statistics, no doubt.

2310. It is not a question of statistics exactly. The question of whether plaice in the North Sea are thinning is not, as Mr. Archer said, a question of statistics, because they have not statistics distinguishing catches in the North Sea from catches outside the North Sea; but it is a question of the personal knowledge and general impression of men who have the most weighty reasons for wishing to be correctly informed. I put it to you whether you think that that kind of practical knowledge is sufficiently taken into account by the people who are making these scientific generalisations?—I do not think it is. I do not think that it is taken into account. They simply go on with statistics.

2311. But I am sure you will recognise that it is important to know more than the superficial aspects of statistics on subjects of that kind?—May not these people that you are speaking of have some interested motives to say that their people are correct? The people in the trade may be biased and want a particular kind of legislation. I do not say that they do. But in the case of Hensen and Brandt they are not biased; they do not care about legislation—whether there is legislation or not.

2312. We all know great writers have distinguished different kinds of mental bias. Do you not think that it is very important for the scientific man not to confine himself to his experiments, which may be laboratory experiments or may be test experiments, but to try and get the information from people who are practically concerned in the matter?—Yes. The Germans do not take much account of the outcry of fishermen and others because they successfully disposed of an outcry of that kind in the Baltic a few years ago. It was found in certain springs that there were prevailing winds from the east, and that those winds drove the floating eggs into the various straits here (*pointing*), and in a way out of the Baltic. Now, it was found that three or four years after the year in which these abnormal winds occurred there was a great outcry among the fishermen against over-fishing. German authorities did not regard that outcry as having any weight, because they regarded the fact of no fish being found there as being due to purely physical reasons, the reason that some

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years previously there had been prevailing easterly winds which drove the floating eggs and larvæ out of the Baltic. They disposed of the argument on one occasion, but it was impossible to do so always.

2313. That case illustrates very well one of the ways in which you must distinguish between the weight of that sort of practical evidence in different matters. The Germans showed that the fishermen were mistaken in their idea of the causes, but the fact that the fish were scanty was not in dispute. Now, I suggest to you about this North Sea problem that the fact of there being a real falling off is alleged by a great number of people who have pretty good reasons to know, and are not very obviously interested in proving it, and the fact may be erroneous, but it requires more serious discussion, I suggest to you, than the Germans apparently have given to it?—That may be, but to return to the Baltic point. Do you not see that if the German Commission had recommended the Government to restrict the fishing in certain areas that would not have removed the physical cause—it would not have produced any increase of the fish. They would have struck at the wrong antecedent.

2314. One would be quite prepared to believe that they are right in saying that the cause was not what the fishermen stated, and, therefore, that the remedy was not what the fishermen desired; but I suggest that in this North Sea problem it is a question of facts—the facts are more or less disputed?—I do not quite follow you.

2315. Well, I suggest that in the North Sea there is a real dispute about facts without reference to causes or remedies, and that it is possible that the German observers may not have sufficiently studied the evidence that there is from practical sources as to the facts?—Yes, it is quite possible. I do not quite agree with Professor Brandt on this point; I talked the matter over with him when I was at Kiel, and he did not quite succeed in convincing me. I am simply giving the expert opinion, and I differ from Professor Brandt.

2316. (*Chairman.*) Do you mean that there is a falling off in the fishery?—Yes, I think that is fairly evident, because they seem to be landing smaller fish. They do not give the fish a chance to grow up. The average size of the fish seems to be on the decrease.

2317. Is it a falling off of round fish or flat fish?—Both round and flat, but more particularly flat fish. May I ask if the question of the annual grants made by the German authorities would be of any use?

2318. Yes, perhaps you could hand them in?—I will tear off this page from my notes and save a lot of time.

Memorandum handed in by Witness.

The annual grant made by the Prussian Government for the expenses of the Commission is £7,500. In addition, in the year 1892, a subsidised biological station was established at Heligoland. The cost of fitting up this station, exclusive of the purchase of the building, was £2,400. The funds granted for the upkeep of this station were for the financial year 1897-98, £1,037 5s. Large grants were also made by the Prussian Government for special purposes, for example, the "Valdivia" and "Gauss" Expeditions. In addition a large annual grant is made by the Government to the Zoological Station at Naples, where German students and investigators are trained. Germany has granted (since about 1885) the annual sum of £20,000 to the "Seefischerei-Verein" for the benefit of the fisheries. For the forthcoming international scheme of sea investigation the following grants have been made:—For annual expenses, £7,500. Of this the German Empire contributes £6,000, and the Prussian Kingdom, £1,500. In addition £1,250 is to be spent on the initial fitting up of a ship with scientific instruments, and for the fitting up of two new laboratories (in Kiel and Heligoland), £875. The steamer being built for the use of the new "Commission" is estimated to cost £15,000.

2319. I suppose in this question of depletion or deterioration you always have to take into account the tendency of the human mind to hanker after the good old times?—Yes.

2320. People think that they caught bigger fish more often when they were young, is not that so?—Yes.

2321. That no doubt has to be discounted?—Yes.

2322. (*Mr. Archer.*) Is not there the further fact that if you have, we will say, 100 boats fishing the same stock of fish as formerly 10 boats fished for, that they would get a less quantity of fish per boat, and the fishermen only base their opinion as to the rise or fall of the fisheries on the actual quantity of fish that they themselves get in their own boat?—Yes, that is a fallacy that several English writers have fallen into in statistical observations.

2323. I think that your evidence however is in favour of the advisability of plankton research?—Yes, I think so. I think that it is the only way that we can get a census of the seas.

2324. And I understand that it depends to a very great extent upon the value of the samples which you obtain—whether the samples which you obtain are taken from a large area?—Yes.

2325. Just to go into that question a little in detail: what is the area of the opening in your net?—The area at present is one square metre.

2326. Is not it one-tenth of a metre which you have got in your book?—I am giving the figures for the net used by Hensen and Apstein in 1895. The net at present used—the net that I have seen used in the Baltic, you can calculate the area from the diameter—the radius is 50 centimetres.

2327. I am taking one-tenth from your book?—Yes, that is right, p. 284. The area of the mouth of the net is one-tenth of a square metre.

2328. Well, then, you talk about 50 observations having been made—that would represent a surface area of fifty metres, would it not?—Yes, this is a net used from the small steamer in the Baltic. I have actually seen it in use. But in the case of those journeys made by Apstein in 1895 they are different and a larger net was used.

2329. Then what is the size of the opening of the larger net?—In the first journey one-third of a square metre, and in the other journey a square metre.—Vide Hensen and Apstein, l.c., p. 6.

2330. Let us take a square metre. Assuming that the area of the mouth of the net was one square metre, then in 50 hauls the amount of water fished through would be 50 square metres of surface of water, and that would represent 50 square metres actually observed?—Yes.

2331. I think you have made a calculation as to the number of square metres which there are in the North Sea. Would you give us that?—Yes, there are some millions—547,623 millions.

2332. Therefore the actual area observed is exceedingly small?—Yes, on one journey. You get three times that on three journeys.

2333. That is not much more. Therefore everything depends upon the amount of variation which you find between one haul and another?—Yes.

2334. To show whether your results are to be depended upon or not?—Yes.

2335. Has that been worked out?—Yes; they have made in certain cases two or three hauls in a very small area within a few hundred yards of a given spot, say they mark a given spot and they make several observations within a fairly wide area—it was difficult to judge the distances at sea—but from 200 to 300 yards, and they have calculated the difference. The difference seemed as a matter of fact to me very slight. You will find references to that in the first paper published by Hensen in 1887. Also a comparison of the greater and smaller nets, Hensen and Apstein, l.c., p. 6. You must remember, of course, that these observations have been carried on for a number of years in the case of the plankton, and you will find the table with curves for the different years on page 327. There is a fair correspondence there; one year does not differ very much from another year, and the maxima have always occurred from the third to the fifth months.

2336. That question then has been gone into?—Yes. Of course, it is by no means exhausted. The North Sea wants re-investigating in order to establish or reject these conclusions.

2337. Now in these eggs which they found, were they mostly flat-fish eggs?—Flat fish and cod; the cod family.

2338. You do not know what proportion the flat fish bore to the cod?—I could not tell you without a reference. You will get it on this paper—I am sorry that I did not bring it—but you can get that quite easily.

2339. Where would that be found?—In the sixth paper given at page 341 as to the methods and results of the German plankton investigations by Hensen and Apstein.

2340. Has the size at which sexual maturity has been reached been studied in Germany?—Yes.

2341. And what are their conclusions?—They are of opinion that sexual maturity does not in all samples of one species become established at a given age or a given length, but there is a great amount of variability. However, in the case of the flat fish and cod sexual maturity comes in at about the third year.

2342. At what size?—I worked myself at the herring family.

2343. Can you refer us to any paper which would give that information?—Yes, there is a paper by Reibisch in the official journal of the German Commission of 1901—there are two parts of it, one of Heligoland and the other of Kiel, this paper is in the Kiel part. There are a lot of figures with regard to the places—more especially the places in this paper.

2344. Now you referred to their having also taken samples at the bottom for microscopic and chemical examination. Do they consider that the ordinary soundings made with the lead do not bring up a sufficient amount of material for biological purposes?—No, I do not think that they are of that opinion. They have special apparatus for the collection of bottom samples.

2345. That is of the nature of the bottom?—Yes.

2346. They do not trust, then, to the ordinary information given upon charts?—No, they do not—decidedly not.

2347. Could you tell us why not?—Well, they go into the thing in far greater detail than that. They examine these deposits microscopically, and chemically, and bacteriologically. During the journeys that I made in the Baltic we had a special scooping apparatus, which scooped up the mud and sand at the bottom, and this material was put at once into a hermetically-sealed flask, in order that the bacteria of the sea bottom should be studied.

2348. What was the advantage of studying the bacteria of the sea bottom from a fishery point of view—did it contain food for fish?—It was found that the bacteria of the sea provided inorganic material for the use of microscopic plants. These plants in turn became the food of copepoda, and they in turn became the food of fish.

2349. You will notice that in the recommendations made at this International Conference it has been recommended that bottom deposits should be collected and studied—you have seen that?—Yes.

2350. Do you think that we shall be able to make use for that purpose of the material and the information which is given on these charts, or do you think for that purpose it would be necessary to start *de novo*?—The information at present available would, of course, be useful, but we want more information it seems to me. I think we want more information with regard to the nature of the sea bottom.

2351. And that can only be got by these special steamers?—It can be got from any steamer with special apparatus.

2352. But it is something in addition altogether to what has been collected for classification purposes?—Oh, yes, quite a different thing.

2353. Then you refer to the voyages of the expedition of the "Valdivia" and the "Gauss" on the last page of your memorandum?—Yes.

2354. What did they do?—The German Government in addition to an annual grant have subsidised special investigation. Of course, the "Gauss" has only recently left Germany, and the results will not be known until the ship returns in about three years' time. The "Valdivia" Expedition I do not think threw any light upon sea fishery problems directly, but indirectly it showed that the plankton which exists in such enormous quantities in the cold seas, in the seas of temperate regions, does not exist in more tropical seas, and that therefore the fish supply of tropical seas which is dependent upon the plankton is not likely to be of such a favourable kind as the fish over temperate regions. That result was obtained from bacteriological investigation. It is found that the denitrifying bacteria at present in the sea are able to exert greater action in the warm seas than in the cold seas, and therefore they destroy a larger amount of inorganic food material, the plants, and, then, if the food material of microscopic plants is destroyed, that then the food of the plankton failing, the food of the copepoda fails, and therefore the food supply of fish—of round fish at any rate—fails.

2355. Have you formed any opinion as to how long it would take to get this information with regard to the nature of the bottom deposits, and the amount of plankton over such a large area as the North Sea?—It would take some considerable time; it would take some years of course to do that.

2356. The observations with regard to bottom deposits I suppose would have to be made at very frequent intervals?—Yes, the Germans have done a great deal.

2357. (*Chairman.*) Intervals of space?—Yes.

2358. (*Mr. Archer.*) At a very short distance apart?—The Germans have done a great deal of that with regard to the North Sea, and we should be simply confirming or rejecting the German conclusions with regard to the North Sea.

2359. Where are the German conclusions with regard to the bottom deposits to be found?—In the Annual Reports of 1887, 1895, and 1899 of the Official Journal of the Prussian Royal Commission.

2360. Could you tell us more definitely whereabouts, or is it all through those reports?—They are found scattered all through the reports. It is very difficult to boil down these things. I could not tell you without access to the volumes. I could easily find out in which particular papers these results are gathered together.

2361. (*Chairman.*) Of what precise value to the problems connected with the maintenance and development of fisheries is accurate knowledge of the whole area of the bottom of the North Sea?—The fish get their food off the bottom you see, and if we know the nature of the bottom we estimate whether it is likely that any food or fish can be found.

2362. Yes, but that is with a view to catching the fish?—With a view to catching the fish.

2363. But I specially said in view of maintaining and developing the fishes?—Well, it seems to me that any information of that kind must be of some service. Professor Brandt regards the importance of the results obtained as being due to the fact that this Commission has had an entirely free hand with regard to their scientific activities. This Commission was appointed in 1870, and it is composed of five scientific men, who are European authorities on their subjects. They have an entirely free hand from the Government, and they are nominally responsible to the Minister for Agriculture.

2364. (*Mr. Archer.*) Would a knowledge of the bottom afford you information with regard to the distribution of fish?—It might indirectly.

2365. Do you mean that if you were to find from trawling operations, or any other observations, that you had a greater quantity of fish at one place than at another that might be accounted for by the difference of the nature of the bottom?—Certainly. This Commission was established at the request of the German Seefischerei Verein, which is more or less a trade organisation—it looks after trade interests, at any rate. Some of the papers are not of much importance, because there is a paper on the Lichens of Heligoland published by one of the Germans. That cannot possibly have anything to do with the sea fisheries. They have published an elaborate memoir on Lichens. That shows the kind of free hand they have got.

2366. (*Chairman.*) You have put a very complicated matter more clearly before us than at all events I have ever seen done.—Thank you. I shall be glad to give any further information.

TENTH DAY.

Thursday, 29th May 1902.

PRESENT:

Sir COLIN SCOTT-MONCRIEFF, K.C.M.G. (*Chairman*).

WALTER E. ARCHER, Esq.
The Rev. WILLIAM SPOTSWOOD GREEN.
Professor WILLIAM ABBOTT HERDMAN, F.R.S.
The Hon. THOMAS H. W. PELHAM.
STEPHEN E. SPRING-RICE, Esq., C.B.

R. E. MARTYR, Esq., *Secretary.*

MR. H. R. REICHEL, called; and Examined.

Mr. H. R. Reichel.

29 May 1902.

2357. (*Chairman.*) You are, I understand, the Principal of the University College of North Wales, Bangor?—Yes; I am the Principal.

2368. Have you been long in that position?—Since 1884, when the College was founded eighteen years ago.

2369. Is the College chiefly scientific?—No; the majority of our students are Arts students.

2370. You say in your note, "The coast of North and mid-Wales from the estuary of the Dee to St. David's Head forms a not unimportant part of the Irish Sea, regarded from the point of view of fishery investigations." I understand that in the investigations going on there you are working with the Lancashire and Western Sea Fisheries Committee?—Yes.

2371. Do your investigations form part of theirs, or do you work separately?—We began separately. I know when it was first started it was entirely a private affair of our zoological professor, who is an expert in fishery work. He has worked under Professor Cossar-Ewart in Scotland. He took it up as a private interest of his own. Subsequently, owing to some work which he had done in connection with the Fisheries Exhibition of the Imperial Institute, the Board of Trade placed him on the Fisheries Committee of the district, and since then he has worked in connection with this Committee and with the help of the Committee.

2372. Is that Committee the Lancashire and Western Committee?—It was the Western, but since the amalgamation it has been the Lancashire and Western Sea Fisheries Committee.

2373. You say: "Such investigations to be effectual must be considered on a large and carefully organised plan of co-operation." What do you contemplate in that co-operation?—I should contemplate something of the same character as exists in agricultural work. There is one great central organisation, and there are a number of well equipped provincial centres in various parts of the country, which are in touch with the central organisation.

2374. Do you mean the Board of Agriculture by the central organisation?—I do; they are largely under its control, and subvented by it. Under this system the local institution is better equipped than it might otherwise be; it also has the advantage of being in contact with the peculiar circumstances of the district, and cognisant of them, and in personal touch with the people of the district.

2375. You say further on: "In addition to the central authority there would seem to be a necessity for the establishment of subordinate departments or agencies responsible for the supervision of the investigations carried on in the fishery areas of England, Wales, Scotland, and Ireland regarded as separate units. Such separate departments or agencies would act in co-operation with the Sea Fisheries District Boards." Would they not be the Sea Fishery District Committees? Do you contemplate another agency?—We contemplate another agency. If such marine stations are established, and are to work on really scientific lines, it seems desirable to connect them with the existing scientific institutions which exist in various parts of the country, just as in the case of Agriculture.

2376. Would not it be easy for the Sea Fishery District Committees to connect themselves in that way?—I think there should be no difficulty. Supposing such a marine station were connected with my own College, we should naturally look to constant connection and co-operation with the Lancashire and Western Sea Fisheries District in working it.

2377. Would not it actually be the work of the District Fisheries Committee?—No; I think it might be part.

2378. Would that be a slight addition to the Committee, or not?—As a matter of organisation it could not be at once a scientific part of the Committee and a section of the College, but there seems to me no reason why such a District Committee should not be in organic connection with a particular department of the College.

2379. The College assuming the position of scientific advisers of the Board?—Yes.

2380. What would be your idea of the Central Board. Do you mean a Board for the whole of England?—The whole of Great Britain. I should say it would be a central organisation, both scientific and trade, the duty of which would be to keep in view the separate investigations of all the different sections, and correlate them and try to produce out of the mass of material thus got together some organised system.

2381. Would your idea be that the members of this Central Board should be representative, that there should be a Welsh member and, say, a member for Northumberland, and one for Scotland, and an Irish member, and so on?—I have not really considered the question. I should think such a central authority would be probably more effective if it was to a certain extent representative of the various localities.

2382. Do you think that there is any risk of local interests and local initiative being stifled by a central authority?—Not if the central authority works largely through a local organisation. Our experience certainly with the Board of Agriculture and our own Department is that the Board of Agriculture has been a help to us; it has not interfered with our initiatory power, but the fact that it was behind us has given us greater weight in our own district.

2383. Have you any knowledge of the Frank Buckland Museum?—No; I have not.

2384. Then you have no opinion as to how far it might be useful to your University College to have that museum partly repaired?—I do not myself know about the Buckland Museum; I am sorry that our expert, Dr. White, has not been able to accompany me, for on this point he might have given information to the Committee. He has been suddenly called away by the serious illness of a relative.

2385. I suppose your idea would be to divide the whole coast of our island into certain local Boards—Lancashire coast down to Wales, for instance?—Yes.

2386. Who have you got to the south of you? Does any person take up the investigation?—The next scientific centre is Aberystwith, half-way down Cardigan Bay. The Lancashire and Western Sea Fisheries Committee comes down to Cemmaes, which is at the bottom.

2387. This Committee is invited by the Board of Trade to inquire and to report as to the best means by which the State or local authorities can assist scientific

research as applied to problems affecting the fisheries of Great Britain and Ireland? Can you give any suggestions in what direction you think the Government could best help in this matter? You say one thing, by the formation of a central council?—Yes, I should say by the establishment of research stations round the coasts at various points in connection with university institutions where they exist.

2388. And where they are not?—Of course it would be more expensive where they did not exist, because the whole scientific apparatus and personnel would have to be created, whereas in connection with an existing institution some of the necessary material and personnel is there already, and merely requires to be supplemented.

2389. I do not know whether there are many University Colleges round the coast which would take up a matter like that?—There is Cardiff, for South Wales, and the Bristol Channel.

2390. Of course, there is the Marine Biological Association, which does valuable work?—Yes.

2391. As to the funds for all this; where are they to come from?—As far as we are concerned in Wales, I am afraid they would have to come from some central fund. The technical fund in Wales has been almost entirely allocated already for educational and technical work, and the small amount which is still available I do not think would be sufficient to maintain an institution of this kind. We calculate that the scheme we contemplate, supposing the Board thought fit to carry it out, would cost for maintenance from £300 to £350 a year. In the North Wales counties the funds available for technical work are first and foremost the Goschen money or the liquor money, as it has been called. This without exception has been already allocated partly to intermediate and partly to technical education. Then there is the penny technical rate, which in most counties has been already levied and allocated. In my own county there remains a small portion not allocated, but it would not be sufficient for an expenditure of this kind. Any expenditure which still can be made from it for this purpose would come in for such work as extension lectures to fishermen, etc., such as are at present being carried on in Carnarvonshire in connection with my college.

2392. You mentioned £350 a year?—Yes.

2393. Would that be enough? What would you expect that would cover?—I take it it would enable us to appoint a new assistant to the Professor of Zoology, who should be a specialist in marine work, at a salary of £150 to £200 a year. You would only get a youngish man, whom you could not expect to keep many years, but still a good man with good training and qualifications, and he would work under the eyes of our professor, who is himself an expert in this work, but who could not give up the whole of his time to it, as he has other work to do in college. Then there would be a workman to keep the place for him, at a salary of £60 or £70 a year, and about £100 a year for up-keep, material, and so on. Of course, there would be an aquarium on a modest scale.

2394. What length of coast would that cover?—My colleague has hitherto been practically supervising the coast from the mouth of the Dee, up to Bangor, round Anglesea, and a good deal round the west coast also.

2395. How far has he gone to—to Aberdovey?—Yes, even as far as Aberdovey.

2396. Besides this agency you contemplate, there is somebody in connection with the Lancashire and west coast fishery?—Yes.

2397. Also making scientific research?—I do not know about making scientific research; they are more, I think, patrolling the district.

2398. From a police point of view?—And for the purpose of informing the fishermen, and so on.

2399. They are not trawling and making observations?—To a certain extent, I think. My colleague has to a considerable extent been doing this work for them. At all events, he has done some work of that kind for them.

2400. Who is the gentleman?—Dr. White, our professor of zoology.

2401. Would your idea be that this £350 grant, within the limits which you have mentioned, would cover all the investigations which are practically desirable for fishery work?—Well, all—it is difficult to say at the moment; I think we could do a great deal, undoubtedly, but whether as time went on that would be all, I should think was very doubtful. Of course one of the features of scientific work is that it is constantly growing, and things which would not be contemplated at the present time might become absolutely necessary twenty years hence.

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2402. You have not used a vessel yet?—No, we have used the vessel of the Western Sea Fisheries Committee and the services of their officers, which have been placed at the disposal of my colleague on various occasions.

2403. (*Mr. Green.*) If sea fisheries work were organised on a large scale, do you think that it would meet the object of institutions like yours, if a certain amount of material was sent to them for examination and report? If a fishery investigation was carried on on a large scale it could hardly be centralised between certain points which you represent, but the material gathered would require a great many hands to work up?—Certainly.

2404. Do you think that your colleague and your young scientists growing up would be well employed in devoting their attention to one family of organisms?—Forming one station which confined itself to one particular form of marine life, do you mean?

2405. It would not have the educational value, I see that?—And, of course, it would not have the same local value if you had some of our local things sent away to other centres.

2406. What do you think could be localised within such small limits?—I am afraid I am not sufficiently expert to give an opinion on that point. If the staff in the particular district was restricted to a small part of the life of that district and had to do with a great deal of the life of other districts as well, it would not be so much in touch with the locality, and would not have sufficient motive force in the locality, and I think that one of the functions of the provincial station should be to move the local people. I can give an instance. In 1893 Professor White was asked quite privately to look into the mussel fisheries of the Conway, which had been declining in value. He made certain investigations and inquiries amongst the fishermen, and drew up regulations which he recommended them to put in force, and being in personal touch with them, and having won their confidence, they accepted those regulations, and put them into force, and the result was that the Conway mussel fisheries have increased by £1,000 yearly. They were declining rapidly at the time.

2407. (*Professor Herdman.*) I will just ask you questions on one or two points. You have told us that the Lancashire and Western Sea Fisheries Committee covers your district geographically?—Yes.

2408. Are they not doing the work that you propose, so far as concerns fisheries, that is to say. Of course, I do not mean to say so far as concerns the work at the College at Bangor—are they not covering the ground that you propose to cover?—I do not think they have got a marine station. At least, I was not aware of it.

2409. Do you not think that the investigations we want are rather such as could be conducted from vessels at sea than those conducted in laboratories on shore?—I should think that the working vessels at sea would be the essential part of the thing, but I should have thought a station on shore, close to the water, in which marine life could be kept under observation in aquaria, was also very necessary. My suggestion was not that such a station was, by itself, adequate to do the work, but that it was almost a necessary part of any system that was to do the work thoroughly.

2410. Do you not think that the laboratory part of the investigations could be done in a laboratory almost anywhere, while the part which is essentially local must be done by means of the vessels on the sea?—I am afraid I cannot answer that myself, and I am not myself sufficiently expert to give an opinion.

2411. Can you tell us—it would be useful if you were able to do so—what kind of work Dr White would propose to do at such a marine laboratory? Has he suggested any?—He is doing a certain amount of work at present in experiments with oyster culture in the Menai Straits, which has been subvented by some private donations. That he is carrying on. I am afraid I could not give you an idea in detail of what he proposes to carry out. I had expected him to be present to supply you with all these details himself; un-

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fortunately he has been prevented by the illness of a relative, as I have already stated.

2412. There is one little point bearing upon the question of funds. I notice in your statement that you say that the Joint Committee intimated that they had no funds which could be applied in Wales to the purpose?—Yes.

2413. Was that because the Welsh representatives had refused to allow the funds to be applied to scientific work?—I do not know that.

2414. I think that was the case, and I wondered whether you could bring pressure to bear upon them to change their attitude, and so set the thing on its feet. I think that is a possible way. Your representatives on the Lancashire and Western Committee are opposed to scientific work, and will not allow the funds to be applied?—I was not aware of that.

2415. That is the case. My object in mentioning it was to know whether the College could help in the matter?—You mean the Welsh representatives were opposed to it?

2416. Yes. So that at present it was carried on by Lancashire alone. Wales would not take part in it?—Do you mean that the funds already granted by Wales are not allowed to be used in this way?

2417. Yes. It strikes me that that would be a possibility, if it were possible to influence your representatives?—I see.

2418. (*Mr. Spring-Rice.*) I should like to ask you whether you have in your mind the present relation between scientific work in this matter of fisheries and administrative duties. You are aware that the Lancashire and Western Sea Fisheries Committee is primarily or mainly for executive duties, more or less of a police nature, and that they have added to them a certain amount of research work?—Yes.

2419. Now, you propose, as I understand, that a branch or a section of that research work should be done in your district by your college?—Yes.

2420. Have you considered, as head of the college, whether it would be possible for you to separate the executive from the scientific work in that manner?—I am afraid I do not quite realise the point.

2421. At present there is a large area stretching from the Solway to Milford Haven, or something like it, under the charge of a body whose duties are primarily administrative, but which also undertakes certain scientific investigations. You propose that a portion of that district should be cut off and put in charge of your college?—No, I do not think that I proposed that.

2422. Perhaps you were not conscious of it, but you described a certain portion of the area, viz., the coast of North and Mid-Wales, from the estuary of the Dee to St. David's Head, as a district in which fishery problems should be specially dealt with?—Yes.

2423. I ask you whether you propose that your district should be cut off, both for administrative purposes and for scientific purposes?—Oh, no. Do you mean whether it should be cut off from this Sea Fisheries Committee?

2424. Yes?—And handed over to the college?

2425. Yes?—No, that was not my meaning.

2426. Then you proposed that only the scientific problems in that district should be handed over to the college?—That is all.

2427. Do you think that is a workable proposal?—I should have thought so. I should have thought that it was possible for the Sea Fisheries Committee and the department of the College to work in harmony, as they have informally been doing for some time, without any assistance.

2428. Then what you propose is that the College should undertake part of the scientific work for the large district?—Yes.

2429. And in that case the College would have to act under the directions of the Committee which is responsible for the large district?—It would have to act, you may say, as the scientific adviser for the district. I take it the relation which I had in my mind was very much that which prevails between the Board of Agriculture and the Agricultural Department of one of the provincial colleges.

2430. Let me remind you, in the matter of your Agricultural Department your business is educational?—Yes.

2431. Or applied science, if you like?—Yes.

2432. You have not got any duties outside that?—Well, of course, part of our educational work is experimental.

2433. Certainly; but it puts no responsibility upon you outside your own College and the farm attached?—No.

2434. So that this proposal you now make is considerably different from what exists as regards agriculture?—Well, it may be to a certain extent.

2435. There is no body having executive duties in the matter of agriculture which is at all comparable to the Lancashire and Western Sea Fisheries Committee in the matter of sea fisheries?—I suppose that the Board of Agriculture has also executive functions, though they are not so apparent as in the case of the Fisheries Committees.

2436. Then perhaps it is hardly a fair question to put to you, but have your scientific advisers in their mind special ichthyological problems connected with this special district of North Wales?—I am afraid I am not prepared to answer that question. I was expecting the presence of my colleague, and I was looking to him for details on these points.

2437. I am sorry that your colleague is not here. But have you heard him propound any special problem?—No, I cannot say that I have, beyond the problem in which Dr. White has been already engaged. Those are local industries.

2438. Those are littoral problems not affecting the sea outside the three-mile limit?—Quite so.

2439. (*Mr. Pelham.*) As regards the staff which you propose to establish. You propose to give a professor something about £150 to £200 a year?—An assistant.

2440. What would his duties be?—Well, his duties would be these. He would be in charge of the local station which would be erected on the coast at the spot we have got in mind; he would be always on the spot, and he would conduct experiments under the superintendence of the professor of zoology.

2441. Would the samples for experiments be collected by your college or collected by the Sea Fisheries Committee?—Well, I should think they would be largely collected by the Sea Fisheries Committee. The staff would not be sufficient to conduct dredging work on any extensive scale and then to examine the results.

2442. You consider that by using your college the Lancashire Sea Fisheries Committee can do it more economically than if they appointed somebody on their own behalf?—I think they very probably could. There exists already in connection with the College a certain quantity of material, and an expert, for whom they have nothing to pay.

2443. But would any of this money go in education?—This proposed money?

2444. This £350 a year grant?—None, except so far as the station would be open to students of the college to go and see what was going on, and possibly for advanced students to carry on experiments under the guidance and assistance of the professor. There would probably be educational work of an advanced kind for such students.

2445. Now, supposing the Sea Fisheries Committee were very anxious to ascertain on that part of their coast the state of crabs, or oysters, or some other kind of fish, what do you suggest that they should do? Would they do it themselves or consult you?—The natural course, if there was a marine station there, is that they should enter into consultation with them, and form some common plan.

2446. Then would your staff be able to deal with all the questions which would arise—biological, hydrographical, chemical, and so on?—I do not think that a small staff of that kind would be able to deal with all the questions that might possibly arise in such a large district.

2447. I rather wanted to follow up Professor Herdman's suggestion, which was that it does not very much matter whether your laboratory is local or not. I want to follow that up, and I want to find out what the advantage of having it local is—partly educational, I suppose?—You make it possible for work to be done by advanced students if you localise it in this way.

2448. For purposes of education?—It would certainly help the training of the advanced students.

2449. Would it help the Sea Fisheries Committee in getting their work done? Would they be able to get it done better than they do at present?—I should think that an additional staff of that kind would be so much to the good.

2450. Do you think that the £350 granted to you would help them more than £350 granted to themselves?—I am inclined to think so, because it is in touch with an institution that has already a good deal of scientific apparatus and scientific advice at its disposal. If you put the two together, the result would be better than if one is left to work singly.

2451. All your work is what you might call a coast work—you have not gone out into the deep sea?—It has been coast work. May I make a statement of fact which I was not able to make before to the Committee? In the event of this scheme being carried out, and Government giving a grant such as we suggest for carrying on a marine station of this kind, we have been practically promised by one of the local landowners a free site for the location of the buildings on the Menai Straits on ground selected by the College itself, and we should be prepared to raise the necessary funds for building upon it. *Mr. H. R. Rowlatt.* 29 May 1902.

Mr. J. R. Ainsworth Davis, called; and Examined

2452. (*Chairman.*) Are you the Professor of Zoology at the University College of Wales, Aberystwith?—Zoology and geology.

2453. In that capacity ichthyological questions come under your notice?—Yes, constantly.

2454. Have you been long there?—Since the beginning of 1884.

2455. You know these coasts well, I presume?—I have a fair knowledge of them. I cannot say I have studied them very carefully in detail.

2456. I do not know whether you have heard the terms of reference to this Committee?—Yes, I have studied them carefully.

2457. Can you suggest any means by which you think the State or the local authorities can come to the assistance of scientific bodies or help in the creation of scientific bodies for carrying out fishery research?—I think so. By subsidising scientific research or investigations connected with marine life they could do so whether that research be carried on in marine stations or otherwise. I think marine stations are more particularly important, and stations inland secondarily.

2458. What is the object of the stations inland at all?—It might so happen that for a particular piece of coast there was no marine station for the time being, while there might be an inland college to do the work, and that could be used as a substitute.

2459. Merely as a centre?—Yes.

2460. Have you formed any scheme or any estimate in your own mind as to what sums you consider would be necessary for carrying on the scientific fishery research in your own district?—I have made a rough estimate. I calculate the expense of initial plant to be about £3,400, and the expense of upkeep would be about £320 per annum as a start.

2461. Including salaries?—Including salaries. This is only approximate, of course.

2462. A forecast?—Yes.

2463. And with these sums what do you think you can overtake?—I think we could add very largely to our knowledge of the marine life of a considerable portion of Cardigan Bay, and we might collect a number of facts having reference not only to scientific work, but to the applications of zoology in the bay, and also having application to the fishery conditions in the northern part of the Irish Sea.

2464. There you would end. You contemplate acting in concert with whatever might be done by the University College of Wales at Bangor, or by the Lancashire and Western District Committee?—Surely, I should try to correlate the work with that done by my neighbours, including Ireland to a certain extent.

2465. Do you recognise that there would be any advantage gained, from a scientific point of view, by having, say, here in London or at one of the universities, a supreme council generally to guide the official research throughout the United Kingdom?—Most assuredly. It would act as a correlating agent, like the higher part of the brain in the nervous system.

2466. What sort of council have you in your mind's eye? Would it be administrative or purely scientific?—I should think the central department ought to undertake the whole business—administrative and scientific. Of course it might split up into sub-departments, and they would take special branches.

2467. You know the Scotch Fishery Board, for instance?—Yes.

2468. Do you think that would be a tolerable type to follow in forming other fishery boards along the coasts of Great Britain and Ireland?—So far as I know it I think it would be. *Mr. J. R. A. Davis.*

2469. And you would put it generally under the direction of the central body?—Yes, a kind of Imperial centre.

2470. Would your central body consist of representatives from your different bodies?—Well, I am hardly competent to speak in detail of that, but there are two things that I should emphasise: firstly, that there should be abundant scientific expert opinion represented upon it on the scientific side, and secondly, that the localities should be recognised, otherwise they would grumble, as they always do in such cases. As to the other representatives, I am really not in a position to speak.

2471. You said £3,400 would be the initial cost?—Yes, and £320 up-keep per annum.

2472. Would you contemplate the hiring of vessels from time to time to be employed in dredging or trawling?—I am afraid I have not done that, but merely named a small sum for the purchase of specimens. If it were contemplated that we should carry on investigations far from shore, we should have to increase the estimate, as that would largely add to the expense of plant and to the expense of up-keep. But the larger the estimate the more important would be the work we should undertake, and the broader.

2473. You have been carrying on work in this way, have you not?—My original research has no particular direct bearing on fisheries, but work on marine forms has been and is being carried on in my laboratory, as the additional part of my evidence will show.

2474. (*Mr. Green.*) The only question that I wish to put to you is the same which I put to the other witness. You speak of helping a general scheme of a central body whose business it would be to organise fishery research—you mean by helping that body, working up things locally?—Yes.

2475. You think that would be the best help you could give to the central body?—Yes.

2476. To specialise yourself locally?—Yes, I think so.

2477. Do you think it would be possible for you to gain any advantage in specialising yourself as to a subject? I had better explain my meaning: in my experience of fishery research we can very easily accumulate an immense amount of material, and the difficulty always has been to get that worked up by a competent set of specialists within a certain time, and if a scientific research at sea and on our coasts is carried on on a large scale the difficulty would become greater than ever. That seems to me almost certain, and colleges such as yours could to a very great extent help the central body by taking up a special form of life, say hydroids, and make yourself special on some particular subject. It comes to a money payment in the long run; but you are asking for a grant to assist a local body, and the assistance you propose to give as a *quid pro quo*, is local research, but if it came to pass that you would do a great deal more by taking up a special subject, and get value for doing that—would that help you?—As to the value for your money, that is a matter entirely for you. The biological side is entirely different. You are proposing a plan by which we different specialists are to work up the different groups of animals.

2478. Yes?—I do not deny that that course would be [illegible] valuable. But the [illegible]

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plete with regard to Cardigan Bay is to work out the biological conditions *in toto*, and the action and reaction between the different kinds of animals and plants, and the chemical and physical conditions. You might send us, for example, all the fishes from our district, but that would teach us very little as to the conditions, organic or inorganic, under which they live, and those are the conditions which determine fishery problems. That is the advantage of the local work in my view.

2479. That would be kept in view in the general research, but it is the details that you are speaking of—you are speaking of working up into detail?—Yes.

2480. Could a small area like that be worked up satisfactorily?—Yes. Professor Moebius has examined, on the lines I suggest, the German oyster-banks of the North Sea.

2481. That is as far as oysters and mussels go, but as far as pelagic organisms go, what do you say?—What you are suggesting is more advantageous for zoology, but then there are different flat fish which do not wander so much.

2482. I think it is most important to utilise all these things?—Yes, surely.

2483. (*Mr. Archer.*) Have you thought at all of the particular fishery problems that you could work out on that coast?—Well, I have thought generally over the question; but what we need most in the first place is a collection of the relative facts, and that would largely determine the cost of the work. If that were done one would have to consider the facts; and if I were concerned with the work the first thing I should do would be to ask Professor Herdman what research he would recommend as having a bearing upon the Irish Sea generally, because things go on in the southern part of the Irish Sea which have a great deal to do with the northern—the growth of fish food, and the transportation of fish eggs, and so forth. But in part of my evidence there are a number of possibilities that I have put down based on the Scottish work. I should take up any one of those that in the opinion of special experts is desirable. I do not think that we know enough about the south of the Irish Sea.

2484. When you say "to work up the facts," what are the special facts to which you refer?—You want to know, for example, the geology of the sea floor, the nature of the deposits—the depths we know—the set of currents, the temperatures, and the flora and fauna.

2485. That, I suppose, would take you some very considerable time to work up?—It depends upon how thoroughly it were done. But working for a year or two there would be enough facts to enable you to go ahead, and do some special work, and meanwhile you could go on collecting the facts.

2486. Do you think that the investigations made elsewhere show that the facts collected in one year are enough to establish the conditions in any particular bay?—Not fully.

2487. I mean even approximately?—Not for many purposes. But some problems can be investigated on a smaller basis of facts than others.

2488. (*Professor Herdman.*) I think Mr. Green and Mr. Archer have asked most of the questions that I had noted down. I feel that it would be very useful if you could have given more detail as to what problems you have in your mind; but perhaps you have answered Mr. Archer as fully as you can on that point?—Well, my own predilection would be in favour of working at mussels, and probably also the crabs and lobsters work.

2489. That is coast work, and not work at sea?—Yes.

2490. You have outlined the details of information that you wanted, such as the inspection of the bottom, and geology, and so on, which suggested to my mind work at sea. All that would be worked for a steamer?—Yes.

2491. You were not contemplating a steamer?—Oh, no. We should have to rely upon facts got by ourselves and facts obtained already by the "John Fell."

2492. That brings me to another point. Do you not think that the Lancashire and Western Committee in the work that they are doing with the steamer are covering your ground sufficiently?—No, I do not. I think that they are adding very largely, of course, to the facts; but then you have only one steamer, I think, have you?

2493. Yes?—One steamer—and the Irish Sea is fairly large, and our area is somewhat removed from the base of operations, so that if you work the south you would have to neglect the north.

2494. Are you contemplating adding a steamer in your proposed scheme?—My scheme does not provide for a steamer, and without it I admit we could not do deep-sea work.

2495. It would still remain one steamer?—No, I should like to see the Lancashire and Western Committee with two steamers. A marine station, of course, on the shore could bridge over the gap between shore work and steamer work.

2496. Which do you think would be most important for fishery investigation—what Mr. Green suggested, namely, that each locality should run a specialist on one particular group of animals, or that each locality, as you suggest, should undertake the general biological investigation?—I consider that the view I suggested is the more important so far as I understand the biological side of it.

2497. More important from the point of view of the general fishery investigation of the country, not from the point of view of your particular locality—of your particular college?—More important from both standpoints.

2498. Yes?—If by working out a group you simply mean the systematics and structure of a particular group of animals, I do not think that would be.

2499. I do not mean that alone—working out everything you can. You understand Mr. Green's suggestion that we should all specialise, that each marine station round the coast should be a part of a general scheme, and that each should be an authority on one group of animals, and send the specialist specimens?—I do not think that that would help biologically; it might help the anatomical question. But supposing you had hydroids from the different parts of the country, it would not increase our knowledge of the conditions determining the struggle for existence.

2500. It would, if all the conditions were put before you?—I do not think that could be done. I challenge that.

2501. (*Mr. Spring-Rice.*) I suppose you would recognise the distinction between the duties of a college as such, and its duties for some external purpose?—Yes.

2502. In the scheme you proposed, may I ask, did you consider first the duties of the college to its students?—No, I did not think of that at all in the first place.

2503. Have you considered whether the sort of duty that you contemplate would work in well with the proper duty of the college?—If I were expected to run the station it could not be done, because I have not the time. But supposing an expert were appointed, and supposing I were made honorary director, or something of that sort, it would certainly strengthen the Zoological Department, because there would be more material available for the zoological students, and they would be able to work with aquaria, and see creatures alive, and so forth.

2504. If you take your scheme, which involves a general survey of Cardigan Bay, that would tend to make all your zoological students primarily concerned with marine animals, would it not?—But the zoological students would only take the marine station as an illustration of a part of their course. They would go through a general course of zoology as well.

2505. Would there not be a danger of their taking up a course of zoology from one side?—There would be a danger, but a danger that could be easily avoided, in my opinion.

2506. Going a step further, would you contemplate that your college should have any administrative duties such as the Lancashire and Western and other Sea Fisheries Committees have?—No, its duties should be purely scientific, in my view.

2507. Have you considered whether it is expedient that the scientific duties within a certain area should be divorced from the administrative duties in connection with the sea fisheries?—Well, it depends how far the cleavage extended. If I, for example, had to conduct some scientific work, I would rather not be bothered with administrative duties, and if both the executive and the scientific side were responsible to some general body things would come out all right I fancy.

2508. It comes back to Mr. Green's suggestion?—How?

2509. That the scientific educational body which you represent, should be given a prescribed task to fulfil by some external authority?—Well, in a sense; but we differ *in toto* as to the nature of the prescribed task. I do not wish to speak, of course, against the other view, only I strongly think that mine for this particular purpose is more important.

2510. But you would not wish the college to have any administrative duties?—No, certainly not.

2511. And I suppose the college would not surrender its independence sufficiently to be at the beck and call of the Fisheries Committee?—Oh, but the connection with the college would not be so intimate as all that. It would be a marine station which would be supported by our resources as a college, but then an expert would be appointed who would do fishery work purely, and would not be a member of the college staff. I do not approve of Principal Reichel's idea that an expert should be appointed as assistant to the professor. Not at all. I think that the expert should run the scientific part of the station, and if I were made director it would be an advisory and honorary position.

2512. You propose a person with allegiance partly to the college and partly to some other authority?—This allegiance would be mainly to the other authority, but the other authority, I presume, would permit the appliances to be made use of for scientific demonstration not primarily related to the fishery business.

2513. The primary thing to this Committee is the fishery business?—And to us.

2514. To us—meaning?—To Aberystwith—for the college, I mean. I have only thought of the assistance to the Zoological Department as quite a secondary thing. I have looked at it from the fisheries standpoint.

2515. Are you looking at it from the point of view of the proper duties of the college, or from that of practical fishery purposes?—The practical result for fishery purposes is the thing that I consider most in this particular matter.

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2516. That is, of course, what we are concerned for here?—Yes.

2517. You put that before the interests of the college?—Yes, of course. I think that it is a fishery question. The college will benefit, I hope; but that will be merely an accident in a sense.

2518. Do you think that that double sort of connection would work?—I do not see why it should not.

2519. (*Mr. Pelham.*) Supposing the Sea Fisheries Committee were asked to make a bye-law regulating the taking of all kinds of fish, either as regards the close time or as regards the size of the mesh or net, do you think that if they wanted advice on the scientific aspect of the case that they should refer to you for an opinion?—Yes, I think so; or, another possibility, that if you had, say, the executive bodies, and the scientific stations both responsible to an agency, that again responsible to the central committee, the agency could get information from both the subordinate authorities and decide for themselves, both authorities being represented on the agency.

2520. You do not suggest that you should have a vessel yourselves?—If funds were forthcoming it would be a great advantage in working out Cardigan Bay and the adjacent part of the Irish Sea.

2521. Then you think that the Sea Fisheries Committee would get more for their money if they consulted you than if they paid an expert themselves?—I think so.

2522. They would get the advantage of the accommodation and resources of the University?—They would, and then if they wanted to know about that particular part of the area there would be some one working there; if they worked it from a distance it would be more difficult. If you wish to ask anything about the aquarium scheme and the co-operation of the Corporation, the Town Clerk is here, and would be pleased to answer any questions.

(*Chairman.*) I do not know that we do.

ELEVENTH DAY.

AT THE SCOTTISH OFFICE, WHITEHALL, S.W.

Thursday, 19*th June*, 1902.

PRESENT.

Sir COLIN SCOTT-MONCRIEFF, K.C.M.G. (*Chairman*).

WALTER E. ARCHER, Esq.
DONALD CRAWFORD, Esq.
The Rev. WILLIAM SPOTSWOOD GREEN.
Professor WILLIAM ABBOTT HERDMAN, F.R.S.
The Hon. THOMAS H. W. PELHAM.
STEPHEN E. SPRING-RICE, Esq., C.B.
Professor J. ARTHUR THOMSON.

R. E. MARTYR, Esq., *Secretary*.

Mr. RICHARD COLLINS, called; and Examined.

2523. (*Chairman.*) I understand you are a member of the Cornwall Local Fisheries Committee?—I am.

2524. Have you been long connected with it?—Yes, since its formation.

2525. How long is that?—Since 1890.

2526. And you have been deputed to represent the views of that committee?—I have.

2527. The object of our Committee is generally as stated in our terms of reference, "To inquire and report as to the best means by which the State or local authorities can assist scientific research, as applied to problems affecting the fisheries of Great Britain and Ireland; and in particular whether the object in view would best be attained by the creation of one central body or department acting for England, Scotland, and Ireland, or by means of separate departments." Could you give us your ideas on that subject? Do you feel that your committee could be assisted by a central board somewhere, or do you not?—Would that embrace the whole of the questions of this paper of reference here, or should I meet them as they stand consecutively?

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2528. At present will you kindly give your opinion of what I have asked? Do you feel that your committee in Cornwall would be strengthened or helped or derive any advantage from the existence of a council or a board or a consultative committee in London, telling you what was going on in other places and comparing notes with you?—That is one great desire of our committee; we have made all the local effort that we feel we could possibly make in various ways. We have supplied our deep-sea fishermen both with logs and with instruments for testing the temperature of the sea in certain localities, and we have got the captains of those boats to record the distances and bearings of certain catches at certain times. That has been done as far as our committee can carry it out. But we find that it is not altogether reliable. We thought if provision had been made in the same way by the Board of Trade or by the State for assisting in this direction, our men

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might feel the responsibility of it to a greater degree, and would keep the logs and testing and other instruments connected with the catching of certain quantities of fish, and keep them far more accurately.

2529. When you mention assistance by the State, what form of assistance do you contemplate?—That, I suppose, would be for the State to decide.

2530. You mean a money grant?—Yes. Our local committees are somewhat hampered, inasmuch as their expenditure comes from local rates.

2531. Do you know how much you spend as a committee?—We spend about £300 a year; that is for our fishing district. But there are other large sums in connection with the fisheries committee for technical instruction: of course that would be outside the rates.

2532. You supply certain fishing boats with scientific instruments—the logs and other things—and they report to you?—Yes.

2533. Do they report where they have found the catches of fish and where they have not?—That is one of our objects.

2534. We have heard that the fishermen do not like to say where they have had good luck. What do you say about that?—It is not published until the reports are printed, as a rule, so that much as they may desire to keep it as a secret, it is not always done. The landing of the fish at the various markets will generally tell where the fish is, and the fleet of boats will follow those who have landed the largest catches, and so they know from the landing of the fish where the catches are secured. I do not think our fishermen, as a rule, in Cornwall are so selfish as to desire to keep it secret.

2535. Then as far as your experience goes you think that it would be distinctly useful and fairly reliable information that could be got by these men?—I do.

2536. Does your committee pay them?—No, they are only paid the expenses of the logs. They are supplied with logs and instruments; there is no remuneration attached.

2537. I think you have never been possessed of a deep-sea boat?—No.

2538. You could not afford it?—No; in fact, they were very reluctant to employ a fishery inspector for a long time. Ours is a comparatively poor county; it is more particularly agricultural, although this fishery represents some 36,000 of the inhabitants of the county.

2539. But it is confined to your county?—Yes, we border on the Devon sea fisheries.

2540. You have a very long sea-board?—It is very long north and south.

2541. Do you think, besides getting assistance in the way of a money grant, that you could be benefited in your committee by information from a central body which would give directions or guidance?—I think it would be a great advantage. My committee is of opinion that if a central board would gather information from various districts there would be a comparison in each district as to what is going on, and information from one district to another might be beneficial in the modes of fishing.

2542. Have you thought out at all what that central body would be—would you have it a representative body?—I think it would be desirable that there should be a representative from each committee.

2543. Are there great fluctuations in the catches of fish in your case?—There are very great fluctuations in Cornwall, especially in migrations of fish—shoals of fish. Of course, Cornwall is dependent a great deal upon the migrations of fish, and we have found that within the last ten years the migrations are very uncertain. One of the advantages derived from the testing of the temperature of the sea, I think, would be to inform us as to the influences operating to affect the migrations.

2544. Are you pretty well satisfied that the migrations do to a certain extent depend upon the alterations of temperature?—Oh, yes, perfectly, from life-long experience. I have been engaged in all branches of the trade—deep-sea trawling, deep-sea long lining, drift-net fishing, and seining. Of course, Cornwall is a great seining county, and we depend upon the migrations of pilchards and herring and mackerel.

2545. Are these migrations as great at sea as they are along the coast?—Yes, particularly this season.

2546. Has any study been made of the relative degree of saltness in the sea by your committee?—I am not in a position to give you information upon that.

2547. (*Mr. Crawford.*) You have a rate over the whole county, I think?—Yes.

2548. Do you know how much it is?—I could not say. Of course, we make a precept upon the county for the fisheries committee expenditure; we issue a precept upon the county.

2549. And your precept is about £300?—Yes.

2550. (*Professor Thomson.*) You said that the information was not altogether reliable. For what reason? Is it for lack of will or for lack of skill?—In some instances, possibly, it would be for lack of skill. Many of our fishermen, in the western part of the county particularly, are not educated men, and, on the other hand, they do not feel altogether the responsibility of it, and in some cases they may not devote their time to it.

2551. Do you think that a little remuneration would make the information reliable?—I think it would; generally it happens that way.

2552. (*Mr. Green.*) You spoke of logs being carried by fishermen. Are they carried by the drift-net men and by the trawlers?—Not so much by trawlers, because the trawlers visiting our coast (we have very few belonging to the Cornish coast) mostly come from Lowestoft, Brixham, and Plymouth, and they more particularly trawl upon the north coast of Cornwall; but the logs are carried by our drift-net men, who go a long way out to sea off the Irish coast and Scilly Islands, ranging twenty miles off the Cornish coast as near shore as the fish approach, following them up.

2553. The drift-net men have not so much object in deceiving the other fishermen as the trawlers might?—They could not deceive one another.

2554. But a trawler might?—Yes, the drift fishermen could not possibly deceive. They follow the markets, and of course if one boat happens to land an increased catch the other boats would follow her the next night.

2555. Where do your boats come from? Is it Penzance—where do you issue your logs?—From Newlyn and Penzance. Those are the large fishing centres from the West and Mevagissey Looe and Falmouth from the North.

2556. But not from Plymouth?—No; Plymouth is out of our district.

2557. (*Mr. Spring-Rice.*) I understand that the problems that you are interested in most affect migratory fish?—Not altogether; that is, our county would be more interested in them, because our trawling is very inconsiderable.

2558. In what you have been saying you have had in mind problems connected with migratory fish?—Yes, that affects our county most.

2559. Have you considered whether there is any particular problem about migratory fish with which your County Committee could deal if it had more funds?—The only means I can see is what I have indicated, namely, supplying the logs and instruments for testing the temperature of the water.

2560. That is the problem to which you attach most importance?—Yes, and that mostly affects drift fishing.

2561. (*Chairman.*) The saltness—have you no information about that?—No, that would be the density of the water, which, of course, is a scientific investigation.

2562. Does that affect the migrations of fish?—I have no doubt it does.

2563. (*Mr. Pelham.*) To how many boats have you been in the habit of issuing logs?—I could not say exactly.

2564. Will you say about?—About 20. There have been also some from Mevagissey.

2565. How far do those boats go?—Sometimes 40 miles from land, and ranging from 3½ miles in shore to 40 miles.

2566. How many of them are trawlers—all those that you issue logs to?—We have not issued any to trawlers. They are all drifters.

2567. How far do they indicate the spot where they have made their catches?—From three to four miles to the greatest distance—just as they find them.

2568. I mean do they tell you the exact spot or merely within a wide area?—They record as near as possible the direct locality in which they have secured the catch.

2569. Where do you take your bearings from?—We

sometimes take our hearings from the head lights, such as the Lizard Light, and so on.

2570. Do you make use of the Marine Laboratory at Plymouth?—The only use we make of it is by the circulation of their reports.

2571. Their boat has done nothing for you?—Not in our county.

2572. Do you think that it would be desirable to have a special boat to make investigations?—Well, not with a view of establishing a laboratory.

2573. I did not care so much about that; but would it for general purposes for obtaining information be desirable to have a special boat regulated by experts, or would you rely more upon your trading boats' returns?—If it could be so arranged, the appointment of a special boat would be a great advantage in ascertaining the nature of the ground and the location of the fish.

2574. But would that be for migratory fish?—No.

2575. That would be more for flat fish?—They could not possibly ascertain the habits of migratory fish.

2576. But in your view it would not be of much use for migratory fish?—No.

2577. And that is the class of fish you are most interested in?—Yes. There are various means of catching flat fish, but that is a very limited thing.

2578. As to the statistical returns, do you make use of them?—Yes.

2579. Do you consider that they are carried out sufficiently in detail?—I do not think that they are reliable at all in our county, especially in our locality.

2580. You are aware that steps are being taken to improve them in some parts of the country?—Yes. *Mr. E. Collins.* 19 June 1902.

2581. (*Mr. Green.*) You said that you attached considerable importance to the temperature of the water in indicating the migrations of the mackerel and other important fish. Do you think it would be an advantage if you knew beforehand what the temperature was further out at sea in the direction from which the mackerel is supposed to come—would that be a help to you?—I think it would.

2582. That could not be done except by a steamer going out some distance?—The cold and heat, of course, affects the quantity of fish.

2583. So that a scientific steamer working a long distance out might help you very considerably?—Very, I think.

2584. Very unlikely, did you say?—It is very likely.

2585. (*Mr. Pelham.*) Do your boats which now make returns make returns as to temperature?—They have done so up to the present.

2586. And they make returns of the temperature of the water where they make their catches?—Yes.

2587. But they do not take any observations as to the sea bottom?—Oh, no; that would more particularly apply to trawling.

2588. (*Chairman.*) I suppose trawlers are not in great favour in Cornwall?—Not generally. The South Coast is very much diminished in flat fish, while the North Coast is comparatively new ground, and is very extensive.

2589. (*Mr. Pelham.*) The North Coast of Cornwall, do you mean?—Yes.

Mr. W. Jeffrey Sanders, called; and Examined.

2590. (*Mr. Crawford.*) You are a smack owner at Brixham?—Yes. *Mr. W. J. Sanders.*

2591. And a fishery member and Vice-Chairman of the Devon Local Fisheries Committee?—That is so.

2592. Have you seen the terms of reference to this Committee, and what we are asked to investigate?—Yes, that was sent to me.

2593. I believe you have some opinions which you would like to lay before us; perhaps you had better do it in your own way?—I did submit an abstract, did I not?

2594. Yes?—I have got a copy of it.

2595. What do you say as to the question whether the State ought to take any share in the management of the fisheries?—My answer to that is that the State is the proper authority by which any effective work can be carried out. The local bodies I do not think could grapple with it as the State could, and I think there would be a conflicting interest.

2596. Have you formed any opinion as to the system under which the State ought to proceed?—Your question is as to assisting in scientific research, is it not?

2597. Yes, for that purpose. In what form ought the State to proceed; is it by supervision or management?—I should say, if it is done as I understand, that there is some work to be done by a vessel or vessels, and that the State should take absolute control.

2598. Have you formed any opinion, or possibly you may not think that that is a matter that you can be asked about, as to what the actual State authority ought to be?—If you are asking whether there should be one central authority—I do not know if that is the purport of your question?

2599. Yes?—Then I distinctly think that that is necessary.

2600. Have you formed any opinion about this—whether there ought to be one authority for the United Kingdom, or whether there ought to be an authority for England, Scotland, and Ireland separately?—I am afraid I could not speak with any fair amount of certainty on the necessities of Ireland or of Scotland, but whatever might be done with regard to putting it all together under one head, I should certainly say that there should be a responsible authority for England and Wales.

2601. As to their operation, you spoke of vessels: what do you contemplate that those vessels should do?—They could carry out investigations, and report on the present condition of the grounds, although one cannot help seeing the distinct disadvantage they would be under through not knowing the former condition of the grounds.

2602. (*Chairman.*) You say provision by the State is the only proper and effective means. What would it embrace altogether; this provision by the State—do you mean one or more laboratories?—I have said that I consider the State to be the proper authority for carrying out scientific investigation, that there should be a central authority for fisheries. It would mean the providing and controlling of proper vessels with the necessary equipment. It would also be able to control laboratory work from a few centres, rather than the multiplication of small and badly-arranged laboratories, worked by separate local authorities.

2603. The central authority to be here in London?—Yes.

2604. I suppose your idea is that it should be an amplification of what already exists in the Board of Trade?—I think as far as my knowledge would go the Board of Trade has got its hands already too full. What I mean is that the field in which the Board of Trade has to carry on its operations is too large. I do not think that they could come specially to a work of this sort in the same way that a distinct authority dealing with these fisheries could.

2605. Who do you think should compose this Central Board? Would it be a representative body?—I think that while the investigations were going on, assuming they would be going on in various parts, there should be a representative committee. I think that is very important, because from my point of view the representatives ought to know better than anybody else the conditions of the ground, the conditions of twenty or thirty years back, the former experience as to what the grounds had been, and what they had changed to.

2606. I suppose you contemplate that the central body which you are sketching out, would be a permanent thing—it is not merely for a time, but as a standing board?—As a standing fixed authority it would be a decided advantage.

2607. There would be always a certain amount of scientific investigation going on to inform this Board?—I think that a central authority should have absolute control of that as well as of all matters dealing with fisheries.

2608. You say here in your third heading A, "As far

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as general conditions apply to obtain more uniformity in bye-laws." Would you have your scientific authority not merely a scientific body, but one with executive power?—The bye-laws passed by local committees are now subject to sanction or disallowance by the Board of Trade. So that if there was a central authority it would be a very simple matter to see that bye-laws passed in any particular district were not altogether contrary to bye-laws in an adjoining district, and I think there would be a distinct advantage from some central control. To this extent there would be executive power.

2609. Does not that exist at present in the Board of Trade?—I do not think so. I would like to give a case in point where marked differences occur in the bye-laws of adjoining counties. Devonshire has bye-laws which keep certain grounds closed by prohibiting trawling. Cornwall has nothing of the same kind. Now I think that a central authority would perhaps show Cornwall that if such regulations were necessary for Devon they would be equally so for Cornwall. It would be stretching a point to compel Cornwall to have it, but still Cornwall has little or nothing in the shape of trawlers, and does not realise this question in the same way as Devonshire does. I may say that we have had many of our trawlers fishing on the Cornish coast for the last two or three months, principally at Port Isaac bay. One can see from the various classes of small fish, but principally soles, which come in, that there is far more necessity for restrictive bye-laws in that county than in Devon. That is what I mean, that some central authority would be able to deal with that and keep more uniformity in the bye-laws.

2610. You look upon it as an important matter that there should be vessels purely for scientific research?—I think that it is a distinct advantage that work of that nature should be carried out, and I think that vessels might be selected for that purpose with advantage, with a trained naturalist who would be impartial in any evidence that he gave or work that he accomplished. Of course, fishermen are always more or less biassed by personal interest—they are bound to be.

2611. We have just learnt from a gentleman in Cornwall that satisfactory statistics are obtained from your fishermen in the way of temperature of the water. Is there anything of that sort in Devonshire?—I think that the work mentioned is solely the work of Mr. Cunningham, who has been under the Technical Education Committee of the Cornwall County Council, which has been responsible for the work that you mention.

2612. Do you think that there would be an unwillingness on the part of fishermen to let a local committee know where they had to go to get the fish, or where they had not? Could you rely upon them to be fairly truthful in such matters?—We think they would be, generally. Of course, trawling is carried on under such different conditions. That is, one haul of any one vessel would be on one ground, but at another time it would be on different grounds altogether. That is to say that the take of one voyage may be, and often is, from a variety of grounds. Of course, the matter is very obvious that if a fisherman had been infringing a bye-law and fishing in prohibited areas he would not tell.

2613. Exactly, he would not incriminate himself. I gather it is of great importance to the fishing interest to know what the variations are, and why there are shoals of fish in one season and not another, and if one could get information from the fishermen themselves it might be of great importance, might it not?—It might. The condition that you refer to would be under drift-net fishing rather than trawling. That is, the fish caught by drifting would go more in shoals than fish caught by trawlers.

2614. Have you noticed great differences, and also great fluctations in the numbers of the supply of fish?—Do you mean from season to season, or over a given number of years?

2615. From season to season in the same locality?—Last year we had a very great scarcity on our own local ground that we could not account for, not only a scarcity of fish, but we could not get any good-sized fish at all. But what is even a more important matter is the migration of fish from a district. We have marked instances of this in the red mullet and hake.

2616. Had you any means of tracing or arriving at the reason of this?—No, none whatever.

2617. It would have been important if you had?—Naturally; it would quite depend on how far scientists could help us. If it were possible for scientists to show the reason where they might be expected, and why they were somewhere else, that would be an advantage.

2618. Do you mean where the fish are?—That is so.

2619. (*Professor Herdman.*) You talk of a steamer investigating the condition of ground. By that, do you mean simply the fish that are caught there?—Of course, an investigation would naturally show that, but I think in addition to that it would show the nature of the ground with regard to its production of food.

2620. Have you had any experience yourself of any scientific investigations of the nature of grounds?—I was a fisherman for several years, and I have done not a lot of work, not enough of work, to speak with great authority, but some little work on board of the Plymouth Laboratory steamer, and I have helped them a considerable time over fish they had marked and set off; that is I think—perhaps I ought not to give the figures too definitely—500 plaice last year were caught, and a number of them I helped to set off; about 10 per cent. of those were brought back, caught a second time. I have taken all that has been brought to Brixham, and that is a very large percentage of the whole; so that, as far as that goes, I have been connected with the scientific work.

2621. You have seen experimental hauls?—Yes.

2622. The dredging and tow-netting and such kind of work?—Yes, but more particularly in trawling.

2623. Have you formed any definite opinion as to how often such hauls would have to be taken, and how close together, in order to give you all the information that you require as to the condition of the bottom?—That would quite depend upon the extent of the ground that you were fishing over. If you were dealing with restricted areas it would not be very difficult, and you would soon settle the matter; but if you had a wider area you would want a greater number of hauls, for 20 or 30 square miles, say, to what you would for four or five miles.

2624. What extent of ground could one steamer working from a centre anywhere you are familiar with, Plymouth or Brixham, cover?—Well, I should say one steamer could very easily cover the whole English Channel without any difficulty at all.

2625. You think she could give you very good information, and sufficiently detailed information, as to the nature of the ground at all times of the year in an area like the English Channel?—Yes, without any difficulty at all.

2626. Well, then, another point. Why do you consider that a central authority would be better for the regulation of such work than the local Sea Fisheries Committees?—The local Sea Fisheries Committees, of course, might represent anyone as far as the bulk of the representation goes for the moment. If you take the Fishery Committee that I belong to, I do not say that they do not endeavour to do their best, but the Boards of Conservators—and there are a large number in Devon—have the right to appoint one member for each Fishery District, and then, of course, the county council appoint members. The Board of Trade appoint fishery members from the outside, and as far as my experience goes the Board of Trade are extremely careful to try and get fishery representatives; but the other men know little or nothing at all about fishing—that is, deep-sea fishing—yet they have executive power.

2627. And they would not be a suitable body to regulate the scientific work?—That is my point from that one side; but the other point, and the more important point, is that there would not be uniformity in the different counties. I think you have a sample of that in many of the bye-laws.

2628. Do you think, if an arrangement were made by which the district committees could consult together, that their work could be co-ordinated so that they could work usefully together?—There ought to be an advantage to come from that; but each county would still have absolute freedom after consultation: they might practically wish to have their own way and follow their own interests.

2629. (*Mr. Archer.*) Do I understand that you would like to take away the power of the present committees to make bye-laws, and to give it to the central authority?—No, I do not think that would be wise; but I do think that the Board of Trade might attempt, or the central authority, presuming it to exist, might attempt to bring about uniformity, whereas now the

local committees move themselves, and there is no incentive to move from any outside authority.

2630. But you see the initiative has to rest either with the central authority or with the local board. If it rests with the local board then the central authority could only approve or disapprove?—That is under the present conditions, and here I think there is room for amendment.

2631. Could you have anything different?—I do not see at all, if you take the initiative of authority, why it should not be suggested that more uniformity should exist between such counties as Devon and Cornwall. I think that it might be acted upon. Cornwall is practically without any trawling; it is almost exclusively drift and line fishing; so that I should say, a Devonshire fishorman, and particularly a Brixham man, who goes over a wide range, would know more about their coast, and particularly the bottom conditions of the grounds, than the Cornishmen themselves.

2632. Would not such suggestions as you refer to come better from the committees than from a central authority?—I think not, but the disadvantage is that outside of themselves there is no authority attempting to bring them together or to initiate legislation.

2633. (*Mr. Green.*) You say that in Cornwall the fishermen are not interested in prohibiting trawling there, because they are not interested in trawling; am I right in that?—I would not say that so much. I think I endeavoured to say to Mr. Archer that they do not know as much of the conditions, because there is but little trawling from their coast.

2634 Do they not fish with lines on that same ground?—That would not give the results to show the quantity of immature fish. A man might be a very long time lining there, and would not know that there were immature fish in the same way as he would with the trawl or seine. It is inshore, where the two interests come in actual contact, that the feeling you mention exists.

2635. In my experience it is where they are not interested in trawling that they are most anxious to get trawling prohibited. It is the liner generally in my experience that clamours for the prohibition of the trawler?—Yes; of course I am not saying that Cornwall should not put restrictions, but I do say that it would be better for these or any two counties working in such close proximity that they should have more uniformity. If I might instance a case in the Devon bye-laws as they exist, formerly the Brixham fishermen very largely fished in three fine bays on the coast of South Devon. There was a lot of indignation from being shut out of those bays. The Plymouth trawl fishermen—also in Devon—never felt the restrictions, because their fishing is done more to the westward, that is, on the Cornish coast, where there were no restrictions to fish inshore; while further on in Devonshire, in close proximity to the Cornwall coast, the thing is forbidden.

2636. (*Mr. Spring-Rice.*) Professor Hardman asked you some questions about studying the grounds; do you Brixham people know pretty well the parts of the sea in which it is no use trawling?—Oh, yes.

2636*. You do not require any further or more formal survey of the sea bottom from that point of view?—I think not, except in the case of areas outside of the mouth of the Channel. I do not say that there are not some fishable banks that it will not be an advantage to have a survey to know, and it is not improbable that profitable fishing might be found in parts of the English Channel, such as "Hurds-deep" and other grounds between Portland and Dover which have not been much worked; but still, such information is got by the steam trawlers to some extent.

2637. The steam trawlers go further afield?—Yes.

2638. But, taking the Brixham fleet, and the areas over which it is likely to fish, they know which parts of the sea are not worth fishing, where the bottom is rocky; do they not?—It would be so; but I do not think that it could be in the sense in which you put it, that the parts were not worth fishing. It would mean more; that they cannot fish because of the condition of the ground.

2639. It would be impossible to fish?—That is so. Our vessels have worked at the Bristol Channel for the last eight or ten years, and we find very profitable fishing—it is not that they might not fish, except that the foul ground soon pulls their gear away, and especially with the strong tides of the Bristol Channel; they cannot work all the ground for that reason.

2640. My object was to find out whether they knew approximately the areas in which they could not fish?—Yes, they do know that. Of course, in fishing with a sailing trawler it is very difficult in some of the restricted grounds. For instance, in the Padstow ground, just off Padstow, there were very considerable quantities of soles brought from there this year, when it is a lea tide—that is, going in the direction of the wind; there is no quantity of ground for the vessel to go up the whole of the tide, and they let an hour or two of the tide go before they put a trawl down, and then they get into the foul ground and get in considerable difficulties with their gear before the tide is finished.

2641. But they do not require any further survey of the bottom of the sea from that point of view?—I think not, except that it might be possible to find new grounds.

2642. You referred to the absolute necessity for some practical representation on the committees spending money for scientific research; you also express your opinion that research work should mainly be done by the central authority?—Yes.

2643. May I ask what you have in your mind in that; do you suggest practical representation?—Mainly this, that the University man, who would probably be a naturalist, and take up that line, would know all that he requires, or what he wants to know, from the grounds as the result of his experiments, and should know from the fishermen; but in the working of the vessel, and as to the nature of the gear, and the proper returns of fish and bottom soil, he would know nothing, and there comes the need for some strong representative to see the work satisfactorily carried out. The man might be working with a trawl; but except it was in a right condition, he would not get the same result in a month that a practical man would in a week.

2644. That suggests a practical fisherman on the boat which is making experiments?—That, of course, would be always necessary. What I mean is this—the incentive to a man who has got charge of a boat is not always to bring the very best results. He would save a considerable amount of labour by bringing lesser quantities, although one hesitates to say it. I am only saying to some extent what I have seen.

2645. One understands the necessity for practical advice in the work; but do you mean that whatever body is responsible generally from the shores for spending money on this research, it should include practical fishermen?—I would only mean to any special work. I do not mean administrative work, but work for investigations going on over a given period should have practical as well as scientific representation.

2646. (*Mr. Pelham.*) Do I understand when you laid great stress upon there being a central board that you were thinking of scientific investigations rather than administrative work?—No, from all points of view.

2647. Do you not consider that for administrative purposes the Board of Trade is the central authority?—I think that in the field over which the Board of Trade has to travel its control is so large and wide that in such a matter as this some distinct authority is necessary.

2648. It is already a central body, but you want to make it more efficient?—For instance, if we take the representation in Parliament, that is generally done over fishery, and all other matters by the President of the Board of Trade. I do not think that it could be expected to do specialised work over such a wide area.

2649. But you want to make the central authority not more central, but more efficient?—Yes, more central and efficient.

2650. But your recommendation, or your suggestion, is not for more centralising the work, but for making the central organisation more efficient and more detached from other work?—That is so.

2651. Have you had much to do with bye-laws which have been proposed by your Fishing Committee?—Yes, I have been on it from its start.

2652. And I suppose you have attended inquiries held by inspectors of the Board of Trade?—That is so.

2653. Have those bye-laws been disallowed or altered by the Board of Trade?—Yes, there have been some cases.

2654. Do you think that the Board of Trade, or its officers could be done anything more than they have

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done to make the bye-laws uniform and consistent one with another?—Well, I think this, that when bye-laws are passed the intention—the object aimed at—should be made very clear; and I certainly think that there should not be, as I said before, in two adjoining counties such absolutely distinct conditions.

2655. Do you suggest that if bye-laws were proposed by Cornwall, and another set of bye-laws by Devon, at about the same time the central authority might overrule them, and make them more or less uniform for the two counties?—Yes.

2656. Do you not think that they would be very much resisted by the county which was overruled?—No, I do not, because I think that the conditions would be practically similar in the two counties. The only thing is that the interest might be different, as I said, in Devon and Cornwall, and the interest of the one might not show the necessity for bye-laws, as the interest does in the other.

2657. Do you suggest that the Board of Trade or the other central authority should compel the Cornish authority to prohibit trawling?—I do not say that, but what I say is that the Board of Trade should certainly satisfy themselves that there was a necessity for passing bye-laws in Devon restricting certain areas. If the Board of Trade had so satisfied themselves that restriction was necessary in Devon, they should be satisfied as well as to the necessity of restriction in waters so close as Cornwall, where similar conditions exist.

2658. And they should reject the Cornish bye-laws, or add fresh bye-laws to their code of bye-laws?—I do not say that there is any need to reject, because it is not a condition put forward by them; but if the Board of Trade, as I presume that they would, had satisfied themselves as to the necessity in Devon, I do not see why they should not advise a similar restriction for the Cornishmen, and not leave them altogether out of consideration.

2659. You think that they should bring more pressure to bear?—Certainly.

2660. Do you think that a separate authority, as a separate authority, would be better able to do that than the Board of Trade?—I think so, because we should look upon their work as distinctive to fisheries.

2661. There are three inspectors of fisheries of the Board of Trade who give the whole of their time to this special work?—I do not understand in what form their time is used. I understood that the specialists' time is largely taken up with administrative work.

2662. That is administrative work—the bye-laws are administrative?—Of course that side would be.

2663. You said just now that one steamer established for scientific research could cover the whole of the English Channel?—Yes.

2664. Now, in the course of the year how often would they be able to take specimens from one particular area?—Presuming they were working over the whole of that ground?

2665. Yes?—Well, at least ten times a year.

2666. And you think that would be sufficient. Would you rely upon the results of those investigations to enable you to ascertain whether the supply of fish had increased or decreased?—As I said, I do not see the value of the work in the sense of showing that, only as far as the period they were covering with their work. They could not, as the result of their work, make comparisons as to the former conditions of the ground, when fishermen consider fish were far more abundant.

2667. If they made a trawl, say, every month in 1902, and then every month in 1903, and every month in 1904 do you think that those trawls at a month's interval from each other would be of value to show whether the supply of fish had increased or decreased?—I do not think the seasons would change as rapidly for the different kinds of fish coming and going, but what they would have a fair trial in the month.

2668. One trawl along a certain line might be very different from a trawl to the eastward or westward, for instance?—I would not say half a mile, but on the known grounds, and particularly the Channel grounds, there would be a very marked difference between the results of hauls over every five miles.

2669. And I suppose the currents would vary in the English Channel nearly as much as in the North Sea—the currents would vary at the different times of the year?—No, I do not think that the currents would be affected by the cold in the English Channel as in the North Sea.

2670. Or by the ice?—No, I do not think that they would be at all.

2671. In forming your conclusions as to the increase or decrease of the supply of fish would you rely entirely upon the returns of those special steamers, or would you rely upon the commercial statistics?—As I said before, the steamers could only make a comparison during the period during which their trials were made. I do not think you need rely upon their work as you do, but you want to take the statistics in 30 years to make a good comparison.

2672. But about the future, comparing this year with ten years hence, would you rely upon the results of the trawls of the special steamer, or would you take into consideration the arrangements made by the trading trawlers?—The English trading trawlers in our English Channel are very few indeed. You could rely upon the sailing trawlers as far as they made returns, which, of course, they do not make up to-day, but as regards steamers, particularly set apart for the work, the comparisons would be useful for any period.

2673. I know you gave evidence on the Statistical Committee, and you are aware that the Committee have made a report, and steps have been taken to improve the collection of statistics?—I remember giving evidence, but I did not know that there had been a report made. I have not seen the report at all.

2674. I think we might send you a report. But you do attach importance to getting statistics from the trading trawlers, do you not?—I think it would be an advantage, but I do not think that it would be sufficient in itself.

2675. (*Mr. Archer.*) Do you know what the trawling area of the English Channel is?—No, I cannot give a direct answer to that.

2676. Can you give it approximately?—Of course, you have to take so much off the ground you have to fish upon. It depends where you start. If you go up to the point of Dover I am afraid it is a question I cannot answer straight off. Of course, you have to detach the waters that are not workable.

2677. (*Mr. Spring-Rice.*) Can you give us any idea as to what proportion of the Channel is trawlable?—I should say not more than a half is trawlable; that is because of the bottom conditions.

2678. We were speaking of the bottom conditions?—Yes.

Mr. ALEXANDER MEEK, called; and Examined.

Mr. A. Meek.

2679. (*Chairman.*) I understand you are in charge of the scientific investigations of the Northumberland Local Fisheries Committee?—Yes.

2680. Have you been long in charge?—It was in 1895 that I started my observations in Northumberland. I think the annual reports are in the hands of Mr. Martyr.

2681. Have you a laboratory there?—Yes. It is in a very good position. The water supply is a very excellent one, and the material, that is to say the marine organisms, are in plenty. I may mention that some of them were on exhibition at the Royal Society Soirée last night.

2682. Your Search Committee is granted £100 a year?—Yes, from the local Technical Education Committee. We got that after a good deal of trouble. They give it with a grudge, because they say the work we are doing is not technical education—those experiments which we are making in fisheries.

2683. Besides that, the chairman of your committee puts his steamer at your disposal?—Yes.

2684. Do you largely use that steamer?—Yes, every week in the summer for dredging and trawling experiments.

2685. Then you have got a number of very valuable

statistics?—Yes, and they have already appeared in print for the most part. A good deal of the material is still undergoing observation, but for the most part the broad statistics have been published. I may say that the steamer "Stanley" is extremely valuable for this kind of work, because Alderman Dent, in constructing it, bore in mind that we were carrying on these experiments, and made some alterations, the fruit of past years of experience, in the construction of the boat, which makes it very valuable in this kind of work. It is a larger steamer than the one we had before—the "Livingstone."

2686. Mr. Pelham has called attention to the fact that you had funds besides the £100?—The Sea Fisheries Committee pay for certain other experiments; for example, I am getting a lot of crabs and lobsters marked for the purpose of determining some facts with regard to their migrations, and that expense is borne by the Sea Fisheries Committee. They only pay the bare expense of the experiment.

2687. Do you consider that there is any matter in which the State could assist your local committee? Do you think that a committee such as yours would be better than they are now if they were affiliated to some supreme council?—I think it would be very desirable that the experiments conducted in the past in a haphazard fashion in a local sort of way should be co-ordinated, and State control could bring that about; in that way you could get parallel experiments carried on all round the coast.

2688. You know the kind of work the Fishery Board for Scotland does?—Perfectly.

2689. Would your idea be to have one Fishery Board for England on that sort of lines, or a sort of supreme council for the whole islands?—I should think that almost either case would be a very good change from the present conditions—either a local Board for England or one supreme Board for the British islands. I believe after all it would be more desirable to have one supreme Board than to have three separate ones, for example.

2690. Have you formed any estimate of the money aid from the State that would be required to meet the wants of your Northumberland Committee?—Well, sir, I have not given it the least thought in that respect, for the reason that I think we have a very important district. I have tried to sketch it out as lying between the Northumberland and Durham coast over to the Dogger Bank, and it occupies just that convenient loop that you can see on the map of the international work that is proposed. We could take the lower loop of the portion marked B on that map. I think that being the case, those experiments, if they should become national, or of an international character, should be done in the various districts with equivalent apparatus and equipment. In fact, I think we ought to be put on a basis equal to other people doing the same kind of work.

2691. Are you counting on the generosity of your chairman lending you this boat—it is an enormous donation every year?—I think we may count very well on Alderman Dent to continue the ordinary experiments in trawling as heretofore, but if this scheme of visiting those distant grounds four times a year is carried out, it would be too much to ask him to devote his boat to that, free of cost.

2692. It is his private property?—Yes.

2693. It is a yacht?—It is a yacht, but he makes it pay as a tug steamer when not using it as a yacht. I believe it pays expenses very well, and yet he has a sort of private yacht all the summer to himself.

2694. And he gives it to you?—Yes, for the in-shore trawling. He likes the fishing, and we get him to make it experimental. It has been of great use to us, I can assure you.

2695. There is no doubt of it. When you extend your present laboratory you say you would like to establish a third?—I think it would be very desirable, seeing that we wish to get as much information as we can in relation to fisheries, to have a laboratory at North Shields where the principal fishing takes place.

2696. What is the average cost of keeping up a laboratory?—I should think we would want to put someone specially in charge. There would be the initial cost of building the concern, but after that is passed it could be carried on for three or four hundred a year—that is, at a moderate estimate.

2697. There would be two laboratories in the Northumberland and Durham counties?—It would be a very central laboratory for that district.

2698. Would you, on the same analogy, have about the same number of laboratories all round the coast?—I do not think so. I think that it would be desirable to restrict them especially to places where there are men available for this kind of work. We have a fairly good department in Newcastle in connection with the local college there, and the heads of other departments are willing to assist in this work, so that there is a good deal of the cost already met in that way.

2699. In the collection of statistics, besides availing yourself of your Chairman's yacht, do you get any information from the fishermen?—A great deal. I make a yearly pilgrimage to all the fishing stations along the Northumberland coast, and get a lot of valuable information. It was at the instance of the Technical Education Committee, who wanted me to go to lecture to the fishermen, but I thought it better to give a series of conferences, and give the information in a sort of informal way. I get a good deal of information from them at the same time, and thus get it in a semi-official way.

2700. Have you got them to keep thermometers for you, and work of that sort?—We have not asked them to make such observations; but, for instance, there is a very exceptional fisherman at Beadnell, Mr Douglas, whom some of you gentlemen know very well, who is carrying on the experiments in the marking of crabs and lobsters.

2701. We had evidence from Cornwall that certain selected fishermen were supplied with log books, and that they brought in facts as to the temperature of the sea. Have you anything of the kind?—We get one or two fishermen to carry on the same sort of thing, as you can see in the report which I published last year, for example. They have recorded, in detail, the whole of the catches of crabs and lobsters.

2702. The number of bodies of males and females, was that collected by the fishermen?—Yes, by the fishermen themselves.

2703. Did you pay them anything?—Very little, 10s a year. One of the fishermen—that is, Mr. Douglas, who contributed part of these tables—rather than take the money, said that he would prefer to have the value in books and a good magnifying glass; he is a very good man indeed.

2704 Do you think that the information of these men could be relied upon as to the migrations of fish and the places where they were likely to be found or not?—To some extent it would want to be controlled by other information as well as by direct experiments. You can get a great deal of information from them, but sometimes you have to subtract more or less from such information.

2705. If a man finds a place where the catch is particularly valuable he would be shy in letting other people know about it?—Very naturally; in fact, he would not like to tell his next door neighbour. He would employ some trick to put his neighbour off the track when he strikes a good lay of fish. I should like to add in connection with this proposed North Shields laboratory that it would be desirable to have a trained man there even for collecting the statistics for North Shields. That, of course, is rather outside the reference to the Committee, but I beg to suggest it.

2706. (*Professor Herdman.*) I know you have been carrying on a good deal of practical work yourself, you have been out in the steamer in these investigations?—I go out regularly.

2707. I think it would be very useful if you could give us your idea as the result of that experience of how often and how close together you require to use the dredge or trawl or any other implement in order to get a fair idea of the conditions?—That is a thing that I have thought over a great deal. I was inclined, when I started my investigations at first, to think that perhaps we were rather overdoing it. We devoted one whole day almost to one bay, and I thought it was perhaps a rather severe test, but when you come to think of the conditions that have to be met—the state of the tide and the other elements of variation, on the whole, you will agree we were right, and that is what makes our experiments very valuable. They extend over several hours; in fact, sometimes seven or eight hours' fishing, and in that way practically I think we get rid of most of the elements of variation.

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2708. What would be the size of such a bay as that you talked of? How many consecutive miles?—They would vary from about two miles to about four miles in length.

2709. How close together would your hauls be on the average?—We go on constantly the whole day.

2710. Backwards and forwards?—Yes.

2711. Well, then, suppose you were to take a haul on a particular spot, would you say as the result of your experience that another haul taken 200 or 300 yards away would give different results?—Yes.

2712. And a different kind of bottom?—The bottom does not vary, because it is practically all sand that we trawl upon. It is all sand, we dare not go anywhere else

2713. Supposing you are working with the dredge—supposing the object was not merely to trawl for fish but to find all the bottom conditions—the invertebrates and the nature of the bottom, how close would the hauls have to be before you were satisfied that you had tested the ground sufficiently?—The closer and the oftener the more perfect the result. It would be a question of what area you would determine to investigate, and what time you had at your disposal. For example, last year Dr. Brady and I were dredging off the coast, and we went about 40 miles off North Sunderland first, and then we went down to Souttar Point in about the same depth, and the ground was absolutely the same in the whole of the trials we made, and I am pretty confident—we had about ten stations—that those ten stations indicated pretty well the condition of the life through the whole of that area. Of course, we went this year to re-investigate, and we are going next week on a similar trip for the purpose, among other things, of settling that point, and then we shall be able to make a pretty good map of the bottom for the region just off the coast.

2714. There you found considerable similarity in that particular experience. But you might in another locality find very dissimilar conditions?—Yes, we have made arrangements to try some different ground this time. The report of last year's excursion is in the hands of the printers just now.

2715. To put it in another way, can you give us any idea what area you can undertake with one steamer?—That again would depend upon the amount of time that we had at our disposal.

2716. Supposing you had all the time?—Then I think within the area that I indicate we could overtake it quite easily.

2717. That particular loop?—Yes, that is the area south of B in the chart of the Stockholm Conference.

2718. Well, then, about the plankton, can you give us the result of your experience; do you find it varies much?—Very much indeed.

2719. How often do you think that plankton observations ought to be taken to give an idea of the variations during the year?—Well, I think if it were done two or three times in each season it would be quite sufficient.

2720. At each place?—Yes. But during particular seasons a little further investigation might be desirable, the spawning season—say between February and May, and on different parts of the coast.

2721. Can you make that more definite at all? What do you mean by the season and parts of the coast? How far apart should observation stations be?—In that respect there is a great deal more variation in shore than off shore. We found that to be the case last year for example; we were out in the summer, and did a good deal of plankton determinations, and found certain things. Again we had a man out with a trawler some months later, and he found almost absolutely the same things over again. The one expedition was in July and the other in October.

2722. I suppose your results were only qualitative?—And quantitative as well; the quantitative results were different.

2723. You recognise that that is a variation?—Yes, and a very important variation. That is a point that wants to be insisted upon in these investigations, that the plankton should be measured as having been done in a certain time at a certain rate with given apparatus.

2724. Can you tell me more fully how far apart you think such observations would have to be taken?—I do not know that I could give any definite information upon the point. We have been in the habit during the past year of making them every week, and sometimes oftener, as we have had the opportunity. We make them every week at the trawling excursions, and use a boat off the coast of Cullercoats between times, but in the winter we have practically done nothing, so that as regards our winter plankton I cannot give any information except such as may be based on an occasional trip I have made for the purpose of obtaining material.

2725. Then in these weekly observations, how far apart were the stations?—They were made at different places along the whole length of the Northumberland coast.

2726. You do not mean continuous sweeps with a tow-net the whole way?—No, we have made them off Cullercoats and off Blyth, north and south, and between Amble and Alnmouth, and between Holy Island and the Farne Islands.

2727. On an average how far apart would these stations be; would they be ten miles, or a mile?—There is about seventy miles of length of coast in Northumberland; the stations are from 2 to 20 miles apart, and we may say that the observations extend over fifty miles of coast.

2728. How many observations do you make in the fifty miles?—They would be on the average two or three at each station every year.

2729. At how many stations, would you say?—Skate Roads and Goswick Sands, Farne Islands very often, Druridge Bay, Alnmouth Bay, Cambois Bay, Blyth Bay, and Cullercoats.

2730. That makes eight, I think; and you make two or three observations at each of those every summer?—Yes.

2731. And it extends over about fifty miles altogether?—Yes.

2732. To turn to another point: You were advocating the establishment of a laboratory. Which do you think is most important, for the ends we have in view of scientific knowledge of the fisheries to establish more laboratories, or to do more work from the vessels at sea?—I think it would be more desirable to have more work from the vessels at sea. My idea is, however, to get a man placed at North Shields where he could see the effects of the fishing coming before his eyes every morning.

2733. That would be largely from the point of view of statistics?—Largely from that point of view, and also for the purpose of bringing into use the material in the study of questions of food and migration, and the relative proportions of the fishes. I think it wants a trained man.

2734. By a trained man do you mean a man trained in scientific laboratories?—Yes, a man who would therefore know the things that he would find.

2735. Do you mean a college-trained man?—Yes.

2736. You advocate that that should be under the district committee?—Yes, I should.

2737. Could all the necessary investigations, such as you desire to carry out, be undertaken by your district committee?—I think so—quite well.

2738. Or do you advocate a central authority?—Just for the purpose that I mentioned to the Chairman, that it would be desirable to co-ordinate all this work. I have tried to compare it with the conditions of agriculture. The Board of Agriculture pay a large grant to each of the college agricultural departments, and they are making experiments. These departments are inspected by the Board, and the work reported upon, and brought home in a simple sort of way.

2739. Do we gather that you would not have the central authority taking the place of the Sea Fisheries Committees, but only co-ordinating and regulating their work?—That is my idea.

2740. That co-ordination and regulation could not be got by conferences between the Sea Fisheries Committees?—I know that there is a movement on foot to try to get that. It was brought up at the annual conference last week, but I do not know that that would be quite sufficient. I think that the central board would be very useful not only from a scientific point of view, but from an administrative and commercial point of view

2741. (*Mr. Spring-Rice.*) In what you have been saying to Professor Herdman, I think you referred mainly to work carried on within a few miles of the shore, did you not?—Yes, to a large extent our work has been close to the shore.

2742. How far out do you go; I mean the farthest?—From about a mile to three miles.

2743. It is all within the three-mile limit, then?—It is entirely, as far as the trawling is concerned.

2744. So that the conclusions as to the necessary frequency of hauls and vicinity of stations are derived from experience close to shore?—Yes.

2745. Would you ask us to draw any conclusions as to what is necessary in the broad sea fifty miles from land?—In what respect?

2746. The point is that, as I understand, the varieties of the stations over the area which you work are such as to necessitate stations six miles apart?—Yes.

2747. Would you infer that it was no use trying to get any information about the broad sea except by means of stations six miles apart?—Oh, dear, no; I should not think so. I think that the stations could be very much wider apart, and yet give very reliable facts

2748. Do the fishermen in your district go far out to sea?—Yes, the trawling fishermen go practically over the whole of the North Sea; the others are more restricted, necessarily.

2749. For the purposes of the trawling fishermen the operations would not be of much value?—Only as indicating the condition of the nurseries of the more important fisheries. A large number of the fishes spend their young lives in shore, and from the facts you get there you can gather what takes place outside.

2750. But they do not give the information to you over the fish grounds?—Not at all.

2751. I did not quite understand the relation either of yourself or of the committee to the Newcastle College?—I am lecturer in zoology in the Newcastle College.

2752. Are you the link between the two?—Yes. I am also Honorary Naturalist to the Sea Fishery Committee, and then I look after the laboratory at Cullercoats.

2753. Does the laboratory of Cullercoats belong to the college or to the committee?—It is worked by a committee, which is composed partly of the Sea Fisheries Committee and partly of the Technical Education Committee, and partly of the members of the staff of the college.

2754. Do you think that that combination of science and practical people is a good arrangement?—I do not think so. What I mean to say is that the Technical Education Committee have no interest in fisheries. If it were cookery or agriculture or anything of that kind, they would go into it heart and soul; whereas the Sea Fisheries Committee are at first hand very much interested in the fisheries, and in the experimental work, but their hands are tied.

2755. But as to the connection between the college and the Sea Fisheries Committee what do you say?—That, I think, is a most excellent arrangement, and works splendidly.

2756. The laboratory is of use to the students of the college, I suppose?—Distinctly.

2757. As well as to the practical interests of the Fishery Committee?—Certainly.

2758. Have you any formal relation between the college and the committee?—No. I do not think that there is any formal relation, so far as I recollect. You see, Alderman Dent built the laboratory for us, and presented it to the Sea Fisheries Committee, and I think that it still belongs to the Sea Fisheries Committee; it has not been formally handed over to the college.

2759. One other question: as to the proposal for a second laboratory only a few miles from the first one; does not that rather appear to be a multiplication of machinery?—It appears at first sight to be so, but it is more for the purpose of putting down a station at the most important fishing place. At Cullercoats, although it is very close, still we might be many miles away for all that we can see of the fish landed day by day at North Shields.

2760. Does not that suggest that Cullercoats is the best place for the laboratory for scientific work?—Yes.

2761. But what you want is an observer at North Shields?—Yes, one who could see at a glance by his training how the fishing was going.

2762. Could not these results be worked up scientifically at Cullercoats?—Quite easily, but it would mean that the observer would have to go to North Shields regularly. I would not have time to do it, for example, and someone would have to go to the place.

2763. But it sounds rather an alarming indication of expenditure. Perhaps what you mean by a laboratory is not so big as it sounds?—It need not. We have at North Shields a good circulation of sea water, which by a very simple arrangement could be utilised. It is very convenient to have this town supply of sea water, and as a rule it is very decent. I have myself, for the sake of observation, kept some specimens in a merchant's shop, and these have remained alive for one or two weeks by the aid of the water, and for that reason we can say that the water would do for longh observation, and anything finer could be sent to Cullercoats, where the better supply of water is.

2764. (*Mr. Archer.*) You say the trained man would stay at North Shields. Could you tell us in rather greater detail the sort of information you would like him to obtain?—The sort of information I would like him to get would be to take a careful note as to the proportions of the fishes that were landed every day; anything abnormal that turned up; the conditions as regards the food of practically all the species; the variations in regard to the reproductive organs, and so on. These are all things that could only be done at a place like North Shields, and it would lead to most important results.

2765. How could he get at the question of food?—By examining the stomachs of the fishes.

2766. And you think that could be done at the port of landing?—They are cleaned constantly there, and he could get what he wants.

2767. As to the quantitative variations that you are speaking of in the different hauls of plankton, were there great variations in the quantitative results between different hauls taken at the same time?—No; on the same day we got relatively the same proportions at every haul.

2768. At different times of the day?—Yes.

2769. Whether it was morning, afternoon, or evening?—Not as a rule.

2770. On different days?—The quantitative results were frequently conspicuously very different. I have not the report, but a year or two ago I published a paper on that subject, and with a photograph illustrating the differences between hauls at different parts of the coast. It was most conspicuous. In certain cases the bottles were almost completely filled with the plankton and in others it was a mere sprinkling at the bottom.

2771. At the same place?—At different localities, within a day or two.

2772. How far apart?—One experiment was made at Cullercoats, and the others were made at Farne Islands, and at Skate Roads.

2773. What distance apart?—The whole length of the coast—about 40 to 50 miles.

2774. You said you would expect that the further away from land the conditions would be more uniform?—From the very few experiments I have made that seems to be the case.

2775. You have made some experiments?—Yes.

2776. Sufficient to enable you to form any conclusions?—They are not nearly numerous enough, but we hope to extend them. We hope to have many more in a fortnight.

2777. (*Professor Thomson.*) Have you had any experience of doing scientific work on board trawlers?—I have been out once or twice with trawlers.

2778. Can you recommend it to a scientific man as a way of getting at data?—You can get a good deal of information in that way, and the men are most kind, but the conditions are sometimes very unfortunate for the man that has to go.

2779. It is a very hard life?—A very hard life indeed. I once made a trip with a trawler from Aberdeen to the Fair Isle region. I got very useful material and information on that occasion.

2780. Did not you find it very difficult to work with any continuity?—Yes, you had to take things as you got them; I mean you had to work as circumstances would permit.

2781. You said that you got valuable information from the fishermen, but that you were not quite satisfied as to its reliability?—Yes.

2782. In what way were they unreliable—incorrect or what?—Quite incorrect, because the fishermen are a

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very suspicious class of people, and if they once take it into their mind that you are getting the information for the purpose of making a bye-law, they will rather tell you an untruth, although the truth may be staring them in the face.

2783. The number of fishes in your table is often extremely small?—Yes.

2784. Only sometimes six, eight, and so on. Are your numbers not too small to be of great service?—Could you let me read what you refer to?

2785. I am only speaking from memory, but on looking at this point I noticed some of your numbers—three, five, and so on, plaice. Are not those numbers too small to be useful?—They are, but these are not properly the numbers that we have been basing conclusions upon at all; they refer to a detailed list of fishes caught with the measurements in the first haul for one hour. That does not militate against the conclusions that we have made with regard to the seven or eight hours' trawling in one day.

2786. (*Mr. Green.*) As to the plankton when away from the shore, when organisms went in crowds you might get a very rich haul, but a few miles away you might get a blank one on the same day?—That is our constant experience. You find even in sailing in a steamer that just about the meeting of the tides or a bit of slack water you get a tremendous crowd of organisms, and on each side things are very thin.

2787. So that quantitative observations would have to be very numerous, or they would be quite unreliable?—Yes.

2788. It makes no matter how numerous, you could base very little upon the quantity?—Yes, but those conditions are understood and appreciated by the investigator; we can see where those bands occur.

2789. Yes, near the coast, but not so easily at sea.

2790. (*Mr Pelham.*) I have one or two questions to put to you about this experimental trawl that you spoke of in answer to Professor Herdman; at eight different stations, was it not? What would the length of the trawl be?—You mean the length of the haul.

2791. The length of the trawl. How far would a steamer go in one direction in making a trawl?—The whole length of the bay, as far as the rocks would allow, as a rule.

2792. Were all these made in bays?—It might be said that they were always made in bays.

2793. (*Professor Herdman.*) I thought these eight were not hauls at all, but were the plankton work?—When the trawl is down we obtain the plankton at the same time.

2794. (*Mr. Pelham.*) Do you trawl parallel to the shore?—Yes, in every case.

2795. What distances from the shore?—From half a mile to two miles—I was wrong when I said three miles.

2796. If you make the trawl the whole length of the bay, do you take one back again parallel to it?—Yes.

2797. How many parallels would you have?—About eight hauls is a maximum in the day.

2798. And what distances apart would those parallel trawls be?—They would not be very far. As the tide advances we get closer to the shore. As it recedes we get further out, so that we are not passing over the same ground. In that way we get a fairly broad but constant area.

2799. Do you ever make a haul over exactly the same ground on the same day?—There is every possibility that we cross and re-cross the same line several times. We do not always trawl absolutely parallel to the shore, but we try to make the longitudinal hauls very much alike on each occasion.

2800. What would the average depth be?—From about three fathoms up to 10 fathoms.

2801. At low water?—Just over where the boat lies. I think that would be the mid-water depth.

2802. Do you take the temperature at the same time?—Yes, the bottom temperature would be very useful, but we have not taken any pains to make the hydrographical work very good, for the simple reason that we have been waiting to hear what was definitely proposed for the international experiments, and then we want to carry this on. We have taken the surface and the air temperature with a good thermometer every day.

2803. Is the temperature of the water directly affected by ice in that region?—Not that we are aware of.

2804. Are there any special currents off that coast?—The currents seem to tend for the most part just from the north-east to the south-west.

2805. Does the particular locality of a current vary from season to season?—I am afraid I could hardly tell you if it does. I should think it does to a certain extent.

2806. Would the quantity of fish vary according to the direction and forces of the current?—That is a point, too, that I am afraid that I could hardly give you any information upon.

2807. Have you any special fishing interest in Northumberland, or are the questions very much the same as the adjoining counties would be interested in?—It is very much the same as the adjoining counties. The trawling fishing is an important fishing; the line fishing is an important fishing also—both from North Shields with the steam liners, and with the cobles all along the coast. Then the herring fishing is an extremely important industry off Northumberland, employing a great number of hands.

2808. But you have not a distinct interest from the North-Eastern Committee?—I think we are practically identical.

2809. In fact, you are both interested in the North Sea Fisheries?—Yes.

2810. I am not quite sure that I understood what information you got from the trawlers; how many corresponding trawlers have you?—As regards trawlers, we have not used them much for the purpose of information. We have a few—one or two captains that I get information from very constantly at North Shields; but it is more with respect to the odd things that they pick up, and for obtaining certain specimens I may require.

2811. They have not given information as to the particular localities where they made big hauls?—Not particularly; but sometimes in a general sort of way.

2812. Do you think it would be important to have that information, if possible?—I think it is a very important thing. It would be very desirable that we should get that brought under the statistics information.

2813. The station that you wish to establish at North Shields, I understand, is really something in the nature of statistics, is it not; it is an expert to collect statistics?—It would be very useful if the man that was to collect the statistics was the same man who was to undertake the scientific observations; all the more so if he had powers to get the statistics in a very reliable way.

2814. It would not be necessary for him to make the experiments on the spot, I suppose?—If you mean by the experiments such observations as I should like carried out, he ought to.

2815. I mean that things could be analysed at Cullercoats as well as North Shields?—But the difficulty is to get it brought across to Cullercoats, when it could be done on the quay at North Shields. He is in the midst of it at North Shields, and if the material required had to be taken to Cullercoats it would have to be done at great expense.

2816. You spoke of the supply of salt water; what would be the exact advantage of that?—I should think that once the man was there, and known to be there, he could easily get the trawlers to bring in living specimens, and they could thus be kept alive.

2817. In ordinary circumstances they would not be bringing in live fish?—No. Material of all kinds could be kept alive, and sent across to Cullercoats.

2818. (*Professor Herdman.*) Might I clear up that point about the hauls? I quite understood that the trawling you spoke of first was in the bay, and I did not quite realise about the plankton work, that that was in the same locality?—Yes, exactly the same spots.

2819. So that the stations are in these bays?—Yes

2820. (*Chairman.*) They are not very deep bays?—They are quite close to the shore. We take the surface plankton; and also we has a net tied to the beam of the trawl, and that gives the bottom determinations at the same time; and we occasionally use a net, that Professor Herdman knows, of a rough material for scraping over the ground, and in that way we get most excellent material for extending our knowledge of the life at the bottom.

2821. (*Professor Herdman.*) In such work you do not use the net such as is used by the naturalists at Kiel—the quantitative nets?—No.

2822. Just ordinary tow nets?—We have used only tow nets, but as far as possible under the same or described conditions. We would be very glad to make the observations more perfect in that respect.

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2823. (*Mr. Green.*) You keep the vessel at a certain spot, and you view the net at a certain time?—Yes, and that is done every time.

TWELFTH DAY.

AT THE SCOTTISH OFFICE, WHITEHALL, S.W.

Friday, 20th June 1902.

PRESENT:

DONALD CRAWFORD, Esq. (in the Chair).

WALTER E. ARCHER, Esq.
The Rev. W. SPOTSWOOD GREEN.
Professor WILLIAM ABBOTT HERDMAN, F.R.S.
The Hon. THOMAS H. W. PELHAM.
STEPHEN E. SPRING-RICE, Esq., C.B.
Professor J. ARTHUR THOMSON.

R. E. MARTYR, Esq., *Secretary.*

Mr. JOSEPH HENRY BARBER, called; and Examined.

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2824. (*Mr. Crawford.*) I believe you are Secretary of the Chamber of Fisheries?—That is so.

2825. And Secretary of the London Fish Trade Association?—Yes.

2826. Have you seen the terms of reference to this Committee?—Yes. With regard to that, I think I should say, in opening, that it was not until very recently that it was pointed out to me that the scope of the inquiry would cover the question of an administrative authority. It seemed not at all clear from the terms of reference as to that. I read the terms of reference some time ago, but that did not seem clear. The expression "scientific research" was not generally considered to cover the question of the appointment of an administrative authority, and hence my delay in approaching the Committee, and my being here rather in a hurry, and not, perhaps, as well prepared as I should like to be.

2827-8. I do not know that we can say that the terms do directly involve any administrative authority. The terms are "To inquire and report as to the best means by which the State, or local authorities, can assist scientific research," and then, going further down, it says "Whether the object in view would best be attained"—that is, the object of assisting scientific research—"by the creation of one central body or department acting for England, Scotland, and Ireland, or by means of separate departments or agencies in each of the three countries" But, however, we should be very glad to hear your views as to the reference in any way that presents itself to your mind?—I went to Sir Francis Hopwood, the Secretary of the Board of Trade, for his interpretation of the terms of reference, and he said that, in his opinion, it certainly did include that, and hence my coming here. But, with regard to scientific research, it seems to me that it would be generally understood, I think, throughout the fishing industry, and amongst others who have taken an interest in it, in Parliament and elsewhere, that scientific research should at all times be under the direction of an administrative authority. That is to say, that if there were a central body or department formed for the carrying on of scientific research, that scientific body should certainly be under the control and direction of the central administrative authority.

2829. You think that scientific research ought not to be severed from the administrative authority?—Just so; and certainly it should not govern the administrative authority.

2830. It should be a subordinate department?—Yes, supporting and assisting the administrative authority.

2831. What is the point you wish to make?—You have hardly had time to put together your views, but what is the first thing you wish to say that you would like to bring before us?—First of all, with regard to the appointment of the central administrative authority, there has, all through my time, been a strong outcry for a capable Government department to foster and govern the fishing industries of the United Kingdom. Representations were made some years ago to the Government, and, as the outcome of those representations, Mr. Mundella gave us the present Fisheries Department of the Board of Trade.

2832. What fault have you to find with that system? They have a separate department of the Board of Trade?—The only thing is, that since that time, through the introduction of steam and more efficient fishing gear, the industry has developed to such an extent as to quite get beyond that, and to require a much better organised department than that could, of course, be expected to be. At the Board of Trade we have a very small share in the Minister's time.

2833. Do you go the length of suggesting, as I know many people do, in regard to a score, or a great deal more than that, of departments, that you ought to have a Minister to yourselves for fisheries?—Of course, we should like that, but if that is not possible we should like to have a greater share of the time of the Minister than we have at present. In fact, I think it is almost essential, because during the time that the fishing industry has developed so much, other departments of trade, or branches of trade, have also developed, and it is patent to anybody who has been connected with the Government, or been in intercourse with the Government, as I have been for some years past, that the work of the Board of Trade has greatly increased, apart from fishery matters, and really it has outgrown what could be expected of any one Minister to undertake.

2834. Have you any specific suggestion to make as to the constitution of the new authority that you would propose?—With regard to that, I think that it should be certainly under the direction of one man, and there should be next to him, perhaps, a representative of each of the kingdoms, England, Scotland, and Ireland; but I do not think it is necessary that there should be a great increase in the staff beyond that, except perhaps the addition of one or two experts.

2835. But what constitution do you point to when you say it ought to be representative of each of the kingdoms; what would be the functions of those representatives in your opinion?—Advisory entirely, I should say.

2836. Do you think there ought to be an advisory council?—I do not know that that is absolutely necessary. If we had a very brilliant Minister, of course, it would not be, but there would be no harm in it in any case. I have not much faith in committees for such purposes, committees very often follow one man. I think that just as there should be only one responsible head for the whole, it would be well to have only one responsible head for each country, and if that man is a good man, he is no doubt the best government you can have; that is, if he is a well-chosen man

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Of course, his choice would depend upon the men available and the tact and judgment of the Minister responsible.

2837. Who is the one man that you have in view—who is he to be? You are not satisfied at present with the Board of Trade, and who would he have to be?—I do not say I am not satisfied with the President of the Board of Trade, but we want more of his time.

2838. I do not mean personally, of course?—No. I mean either the President of the Board of Trade, with some other department taken off his time, or, it occurred to me, the Board of Agriculture might be made into a Board of Agriculture and Fisheries. That has just occurred to me, but that is, I think, a matter for the Cabinet to arrange as to the way in which it could best be managed. There would be the giving to us of a Minister's, or a greater part of a Minister's, time, and that would be also an advantage to other departments of trade by relieving pressure at the Board of Trade—which is very apparent. It does not matter how good a staff you have, if the head through whom their work has to appear is overworked, because, however efficient the staff may be, all their work has to come through the head of the department.

2839. But, then, you are aware that the Board of Trade does include a distinct branch, called the Fishery and Harbour Department? You have a permanent head of the department, who is always an experienced official of the Board of Trade?—He is an assistant secretary in that case. But what I mean is, that however experienced he may be, and whatever he may desire to do, it has all to come through the Minister, has it not?

2840. Yes, as far as I understand?—That is what I meant. However experienced he may be, and his staff, and those who assist him, if the Minister has not time, he has to keep putting things off—time being very important, especially in Parliamentary action; and they cannot be put off beyond a certain time—the rules of the House not allowing it beyond a little time. A week's delay may sometimes mean the loss of a whole year.

2841. On that point, as to the constitution of a central authority under one Minister, is there anything further you have to suggest?—No; matters of detail would arise, but I do not think it is necessary to go into them here. If the Minister were well chosen he would, of course, use his discretion in the appointment of other officers, and, of course, everything depends upon the ability of the officers appointed.

2842. Then would you contemplate that the whole staff of this new Ministry should be in London, or where?—It would certainly be advisable to have it in London, as London is the political capital.

2843. For example, you spoke of representatives from Scotland and Ireland; would they also be in the office here in London?—Either that or to come over as occasion required; but, at any rate, they should be in close communication with the Minister.

2844. Then what is the next point you wish to bring before us?—I should say that the great object in view is to establish confidence between the fishing industry and the Government. Everything should give way to that object. I do not think there is much clerical work required, and there seems to be an adequate staff, but, of course, I do not profess to know so much about that as the Government departments themselves; but so far as my experience goes, there is an adequate staff for clerical and inspection duties, and so on.

2845. You mean the present Fisheries Department of the Board of Trade?—In the three—the Fisheries Department of the Board of Trade, the Fishery Board for Scotland, and the Irish Fisheries Department. What is wanted is harmony, which could only be brought about by their being brought under one individual head.

2846. As you have mentioned as your second point that you think there ought to be confidence between the central authority and the fishing industry, are there any steps which occur to you by which that confidence could be promoted? You say that is the chief object?—By appointing popular officials, and that is a matter of tact for the head of the department. That is the easiest and the best way, it seems to me, to establish confidence, and that is entirely a matter of tact and judgment for the head of the department. You cannot make any rules for that.

2847-8. Then what is the next point that you would like to refer to? I want to know that so that I may be able to put more specific questions to you?—With regard to the expense, of course that will depend on the Treasury, and in these times that is an important point. I think from what I have said that it will be understood I consider that very little extra expense is necessary. Of course, there will be extra expense attached to the appointment of another Minister, overlapping one or two departments, perhaps, and perhaps one or two experts; but beyond that I do not think there is any necessary expense. More office accommodation would hardly be required, and the extra expense would be trifling. But what you rather require, it seems to me, is the harmonious bringing together of all the, at any rate, fairly well organised departments which we have. For scientific research we have the Marine Biological Association at Plymouth, and whatever may be said against that institution, if we had a Minister of ability, and one well advised, he could make a great deal of use of that. It seems to me at very little extra expense we could get all that the fishing industry requires from that institution in the way of scientific research.

2849. Since you mention the question of expense, I understand that, speaking generally, you think that the present staff, taking the country all over, would be adequate, or nearly adequate; but then have you considered the question of any grant to existing local societies, such as the Marine Biological Association or any others? Would any expense be called for in that direction?—There is a grant already made to the Marine Biological Association, I believe, and as far as outside opinion in the fishing industry goes, I think that they would be very glad to see a better return for the grant which is already made. That, again, is a matter of tact for the head of the department. Of course, if by their action they showed that they were assisting the fishing industries by their researches, perhaps some money might be required from time to time; but I do not think that would be such a serious matter—it would not come anywhere near the £16,000 per annum which has recently been granted for scientific research.

2850. Are you aware that in England there is a certain amount of work, a considerable amount of work done by the district Sea Fisheries Committees?—Yes.

2851. Have you considered at all the question of the relation in which they and their work should stand to the central authority that you propose?—I think that a good deal could be done in bringing out a better and more intimate relationship between them and the central authority than at present exists. There is great discontent amongst them, and that is again a matter of tact. If there is no sympathy you can hardly get any money that is spent well spent.

2852. You refer to the grant which Parliament has made for better scientific research in the next three or four years, and have you considered the question of the manner in which scientific research ought to be carried out, whether by vessels, or how?—Up to the present that has appeared to me to be a matter of detail waiting entirely for the formation of a central administrative authority. As a matter of courtesy, it might be well for England to join the other Powers in the scientific researches which are about to be made in the seas around these countries; but inasmuch as science must always be, on account of the great expense, somewhat sluggish in its operations, I do not anticipate a very great advantage to the fishing industry from the investigations about to be made. I might further say this—that the conditions are so frequently altering in the seas about our country that by the time these investigations are completed a wholly different set of circumstances may have arisen, and probably will have arisen, which would require another, and perhaps a much more expensive, set of experiments. Of course, if we could determine any general laws from these investigations, which I hope we may do, it might be of some benefit; but that seems very doubtful; nothing to compensate the country for the great expense and delay which must necessarily occur.

2853. Coming back for a moment to your proposed Minister of Fishing, I see that you have told us that you do not attach so much importance to scientific investigation of the kind that is at present being taken in hand, but, on the other hand, what would you expect a Minister to do? What would his functions be?—I do attach importance to scientific investigations; but

they should rather be at the beck and call of the Minister than the Minister trying to follow scientific investigations. I mean for the guidance and administration of our fisheries I would rather depend upon the knowledge of the world and of things generally of a man of affairs than on a scientist or a man who is a so-called scientist.

2854. I understand you would rather that those investigations had been initiated for this country by a British Minister than that they should proceed on the programme of an international conference of scientists; is that it?—I think so, except for the matter of policy which I have just adverted to, as a complimentary policy.

2855. But then, apart from scientific investigation, what else would you expect to be the functions of this Minister practically? What would you expect him to do, and what good would you look to from him?—Generally, to watch what is required from time to time, which must constantly vary, for the fishing industry, and, so fer as a Minister can, he should supply it; and if scientific research is required upon any subject he should have a body at hand to which he could refer for the scientific information, which body I think might, with the necessary control, be the Marine Biological Association. It has been already established at considerable cost. I have been over their laboratory at Plymouth, and it seems to me to be at any rate the nucleus of a very valuable institution.

2856. I rather gathered from the earlier part of your evidence that you looked to a Minister for promoting legislation where that is required. Is that what we are to understand?—Yes, as required; and, of course, a Minister for that reason should be, through his department, well in touch with the industry, and be well supported by the industry; and so far as the industry is concerned, I feel sure that it could not be better organised than at present for supporting a Minister from outside in any action which he may take in that direction.

2857. Were you interested, for instance, in the Bill about the size of fish?—Yes.

2858. Were you for the Bill or against it?—We were for it. Virtually through the Minister, we were the promoters of it.

2859. Do you think that if there was a separate fishery authority a measure of that description would be more vigorously prosecuted?—Yes.

2860. Is there anything else that occurs to you that you would like to bring before us?—I think on that subject that is a good example of where the want of the attributes I have pointed to brought about disaster.

2861. (*Mr. Spring-Rice.*) You seem to be under the impression that, under present arrangements, the President of the Board of Trade, for the time being, is not able to give enough time to the affairs of fisheries. Is that so?—Yes, I think so.

2862. May I ask what reason you have for thinking that the Minister, be he A or B, does not give as much time as is required?—Because the trade of the country has increased so enormously, and the fisheries themselves have increased, and, however good a staff he may have, he has to do more than one man can successfully do.

2863. That is an *a priori* reason?—That is my opinion, and, of course, I have an impression which is based on my constant communication with the Board of Trade, and the outcome of it is, I may say, that there is existing a want of confidence in the Government Department, probably arising from a similar feeling throughout the industry.

2864. Now, have you any case in your mind that you can quote, in which the pressure on the time of the President of the Board of Trade has prevented him from giving as much attention as is required for any problem which the fishing industry has brought before him?—The question of the appointment of a department being referred to a committee like this, seems to show that the Board of Trade was not in a proper condition to deal with fishery questions.

2865. I do not know that that is a proper conclusion to draw, but, however, I ask you now, have you any case in your mind in which the fishing industry has suffered owing to undue pressure on the time of the President of the Board of Trade?—Yes; take the Fisheries Bill, which the Chairman has referred to. That was postponed for years and years and years, after promises had been made by the Governments—both Liberal and Conservative—to bring in a Bill.

2866. But have you any reason for thinking that those postponements were not due to Parliamentary reasons—that is to say, that the pressure was on Parliamentary time, and not on Ministerial time?—Yes; I say that during those years the President of the Board of Trade, who was responsible for fishery matters, had very heavy responsibilities, with regard to railway matters one year, and so on, and, if he had been a Fishery Minister only, he could have given his time; and Parliament, I think, only requires to give a day or two to the carrying of a Bill.

2867. I am afraid your impressions about Parliamentary difficulties are, perhaps, not those which would be usually accepted?—I think, as I have acted in connection with the representation in Parliament of the fishing industry's requirements for upwards of 20 years, I have a very good idea of them.

2868. Taking your own case, when you were dealing with the Board of Trade, you remember what happened to the Bill?—Yes; we would prefer to have a greater share of the Minister's time, as the fishing industries have become so important. Although they may not be important enough yet to take up the whole of a Minister's time, we could do with more of it.

2869. (*Chairman.*) Yes; but Mr. Spring-Rice wants you to point out the specific examples of where the present system has failed, and that seems to me to be quite a fair enquiry?—I could not take a better example than the Fisheries Bill, where there was a six to one vote on the second reading of the Bill, and then it failed.

2870. (*Mr. Spring-Rice.*) I do not desire to take a better example. That Bill was referred to a Select Committee, was it not?—Yes.

2871. That was, no doubt, for Parliamentary reasons which you will appreciate, and do you remember the report of the Select Committee?—Yes.

2872. That was that they thought there was not information available to enable them to judge of it?—Amongst other things, yes. I think that is a very good answer to your own question.

2873. But since then there are steps being taken, or about to be taken to obtain some information?—Yes, since then.

2874. All I wish to point out is that there is no suggestion there that, owing to pressure on the personal time of the President of the Board of Trade, these long delays in dealing with what I agree is a very important and difficult question have been increased. The delays have been due to other causes, I suggest to you?—What I think is this, that the Minister responsible for a department is responsible for it, and, if scientific information is required, he should have it at his beck and call, and have time successfully to arrange and prepare his case.

2875. But, however, I only want to put your proposition to the test of experience, without discussing it further?—But before we drop that, I think I might say that that is a matter of organisation. Before the Minister had the Bill to put before the House, he should have had all the assistance that was required for that Bill to be carried through successfully.

2876. That is a different proposition, which, I agree, you are entitled to put forward; but, passing to another point now, you speak of the want of trust between the present fishery officials and the trade. You are aware, of course, of the system of conferences of representatives of the fishing interests?—Yes.

2877. And you are aware that communications have passed between them and the Board of Trade?—Yes.

2878. Have you any improvement to suggest in that system?—All that I could say is that the conferences are looked upon as an utter farce by the trade. What they say is that they come up there and make representations, which, for some reason or other, do not come to a head.

2879. Can you mention any representation they have recently made, which has not come to a head?—Off hand I do not think so, but I think a reference to the reports will show that there are many representations which have been made in their reports.

Mr. J. H. Barber.

20 June 1902

2880. I understand that at the last meeting the only point which they pressed on the Board of Trade was the question of the Undersized Fish Bill. Were you there?—No, I was not present. I have not had the report yet of that last meeting.

2881. Assuming that to be correct, you are aware of the international difficulties of attempting the passing of any Undersized Fish Bill?—I am aware it is by no means an easy matter. We had great difficulty in assisting the President of the Board of Trade outside, and I am quite aware that a Minister cannot, without outside assistance, carry a Bill of such a nature. I am aware that he had very heavy opposition, and I should attribute his not being able to do that, to the want of a proper department, or proper organisation rather, to assist him.

2882. You changed the word "department" into "organisation," and that is rather important. I should gather, from what you yourself say, that you think that a Bill of that nature, requires a great deal of backing from the practical trade?—Just so.

2883. That is to make it have any chance of passing?—Yes. He was assisted by the Trade to the extent of a six-to-one vote on the second reading, and it failed.

2884. But, can you point to any way in which, by having a different organisation in the Board of Trade, or in other ways, his hands would have been strengthened in Parliament in the case of that Bill?—It was singularly unfortunate at the time, that there were two changes in the Department—on the retirement of Mr. Berrington, which could not be helped because of the 65 years of age rule of retirement. It was most unfortunate that it came just at that time, and that, of course, would necessarily take from the strength of the department for a time. Both those things were singularly unfortunate; I mean the appointment of a new Chief Inspector and the amalgamation of the Fisheries and Harbour Departments; but I think the President of the Board of Trade had very important matters besides fisheries that year to deal with.

2885. But I do not understand yet that you are able to say that the difficulties about the Sea Fisheries Bill, which were Parliamentary, domestic, and international, as you are aware, could have been mitigated by Mr. Berrington not having to go, or by any other organisation at the Board of Trade?—I think if I were speaking in the Board of Trade, I should say a great deal which one would rather not give as evidence for publication.

2886. Taking what you have said, I will pass on to ask you this. Are you prepared to recommend, apart from the Governmental organisation, any improvement in the machinery for bringing the Government department into touch with the trade?—I think the suggestions which I have made to the chairman and to you would have that result.

2887. I beg your pardon, I am afraid I did not make myself clear. I was thinking of the organisation outside Government. You have only got these conferences, which you think are not altogether satisfactory; and can you suggest any improved way by which the Government Department, be it what it may, will get into touch with the views and the requirements of the trade?—I think by the staff of the department mixing more intimately with the trade directly, a feeling of sympathy and confidence would arise, which certainly does not exist at present.

2888. That is rather difficult to understand, or to follow out; but may I put it to you as representing the trade, does it occur to you that the trade might mix more freely with the department?—With regard to that, I myself have been in constant touch with the Board of Trade and other departments, but the trade, I may say, have felt very discouraged lately—especially after the failure of the Sea Fisheries Bill; and there is rather a feeling of disgust, which is most unfortunate, towards the Government departments, and not one of confidence at all. In that connection I am here to-day entirely on my own initiative, because there is such a feeling. I came with a view of bringing about a better feeling of sympathy between the trade and the Government on their side.

2889. We know that the great majority of the fishing trade (I believe that it is so) think that some limit should be put on the size of fish that may be sold, but may I ask you, as an independent and well-informed person on the subject, are you not aware that even if it is admitted that that is desirable, there are numerous difficulties in the way of doing it?—I admit that after the failure of that Bill, our chances of carrying another one are, of course, very much worse than they were before the Bill had been put forward and lost.

2890. That is very disappointing to you, no doubt?—It is very disappointing to us, indeed, after three passings in the House of Lords, and a six-to-one vote in the House of Commons, that that should have been lost on a very small vote in a Select Committee. But what I quite admit is that, through it being late in the session, it would have been a matter of great credit to any Minister to have carried that Bill. That is all.

2891. But I wish to suggest to you, as one acquainted with the trade on the one hand, and with the difficulties, which are not ministerial or departmental, on the other, that, although the trade is naturally disappointed, it is not quite fair of them to put the whole blame on a Minister or a department?—I do not know. They might consider the department and the Minister were caught napping—they do consider the Government was caught napping.

2892. There is only one other point, or, rather, a suggestion, that I wish to put to you. Do you not think that the trade, being as anxious as it is about that measure, ought to make it its duty to assist the Government in any way which may be necessary, for whatever reason, in working on towards taking some other step?—They did assist the Government to the extent of a six-to-one vote, as I said before, and after that they felt very discouraged. I have no doubt they would try it again, but they are almost heartbroken over that subject.

2893. That is very natural, but, for instance, knowing as you know, and as we all know, that one of the great difficulties of convincing people about that is the want of statistics, do you think that the trade collectively will be disposed to make every effort it possibly can to assist the Government in getting statistics?—I do not think the trade attach so much importance to statistics as scientific gentlemen might. I do not think that statistics can be too much relied on. I have read the report of the Departmental Committee, of course. The trade seem fairly satisfied as to the present statistics without any great increase in the efficiency of their collection. Statistics are valuable to this extent, they show us now what we did not know before the formation of the Fisheries' Department of the Board of Trade, how big the fishing industry is, but to think you will ever collect them to such an extent as to show that there is 5 or 10 per cent. increase or decrease in the fish caught is useless.

2894. I do not wish to go into the details, but, assuming that Parliament will not pass a Bill without information of a statistical kind before it, and supposing that a great deal of information could be given by the trade, do you not think that the trade, from its own point of view, notwithstanding its disappointments, ought to do its best to help?—I think they would be very glad to do that, but I think, at the same time, I should feel very much opposed, personally, to putting on the trade any directions in the way of giving statistics, which might be done by a Government department if possible.

2895. But, supposing that there are things which only practical men engaged in fishing can tell you?—But that is not likely. It is not only in regard to the fishery trade, but in regard to other businesses that I have heard from people how they have got to make a return, and they make returns, but whether there is a 5 per cent. inaccuracy or not nobody knows.

2896. The only point I wish to suggest to you is that if the trade will not help itself in ways that are pointed out to it as being necessary to get what it wants, it is not altogether the fault of other people?—I do not think the trade can be accused of not helping itself at all. The trade were quite willing to help this measure, and I think that no other trade, outside a Government department, is so well organised now as the fishing industry. They have their institutions and conferences, which have been held from time to time, and they have been on a splendidly representative basis. I do not think anybody could say that the conferences, which have been organised from time to time, were not thoroughly representative, and I should think you would have a difficulty in finding any other industry in which the organisations are so nearly perfect.

2897. I only wish to ask you on that, supposing it is stated that certain information is essential, and that the information could only be got from the trade, do you think the trade would in its own interest be willing to help in supplying that information?—No; I think they would rather take the view that the information is not necessary, and they would go to Parliament for a vote on a Bill to find a more efficient way of attaining that object. That is their opinion, I think. I mean to say that the opinion expressed by a Select Committee is, of course, the opinion of a Committee of Parliament; but Parliament may, from time to time, as their Select Committees have done, come to different conclusions. If you take the reports of the Select Committees on fisheries, you will find that as they have gone on they have had more data available and better reasons for coming to a conclusion, or they have considered that they have, and in that way, I think, if the question came up again probably statistics would not be given the importance they were given in 1900.

2898. Of course, if the trade takes its own line on the subject, it takes the responsibility for it?—I suppose the country takes the responsibility for anything it does through the Ministers.

2899. No; if the trade takes a line which the Minister of the day considers is not advisable for getting what they want—I only put this hypothetically—then the trade takes the responsibility itself, and it has no reason to complain of the Minister?—I take it that would amount to the Minister being unpopular in the trade.

2900. He might be right and the trade wrong, or *vice versâ*?—Just so; it might be one or the other, but I do not think they would agree with the Minister in such a case. That is what I mean.

2901. But you would not blame him?—No; every man is entitled to his opinion. Periodically one party or the Government is wrong, apparently, because it gives way to another.

2902. (*Mr. Green.*) I think I gathered from you that a good deal of legislation, or proposed legislation, has been delayed by referring matters to Committees and Commissions, which ought to have been dealt with by the central department?—The central department cannot legislate; I admit that. But I take it you mean perhaps that I am of opinion that the Government department ought to be so in touch with the industry that they should have the information which is sometimes sought through either a Committee or a Royal Commission. Is that what you mean, because I agree to that?

2903. That is what I mean?—It would be much better if the officers of the Government departments were so in touch with the fishing industry that they had at their fingers' ends the information which is now sought through a Committee or a Royal Commission, or by some such means. I might say that the referring of matters such as this scientific matter and statistical questions and the salmon fishery question to Commissions is looked upon in the trade as an indication of want of efficiency in the Government department. They think they should have had the information at their fingers' ends, without incurring the delay caused by inquiries such as these. Of course, the question before this Committee is quite another matter, because it is a matter of the reconstruction, perhaps, of that department itself.

2904. Do you think a more complete organisation would expedite matters?—Greatly; that is the gist of the whole thing. If that organisation were representative of the three Kingdoms it would tend a great deal to do away with the ill-feeling between the fishermen, perhaps, of the different countries, and greater similarity might be brought about in the laws relating to fisheries in the different countries. For instance, the Moray Firth question, which has notoriously been the cause of a lot of ill-feeling, might have been avoided had we had one Minister for the three Kingdoms.

2905. (*Mr. Archer.*) You think that the officials ought to be more in touch with the trade?—Yes, certainly.

2906. And your reason for thinking that is so that they may have at their finger ends the information which the trade could give them?—Yes; that is my reason.

2907. But I thought I understood you, in answer to a question which Mr. Spring-Rice asked you, to say that you thought that the trade would not help in giving any information?—Oh, no; on the contrary, they would be very glad to give information.

2908. They would be very glad to give information?—Yes; I am quite at the disposal of all the Government departments, to give any information which is required.

2909. Then you would like to withdraw the answer which you gave to Mr. Spring-Rice's question?—I think you must have misunderstood it, we were then talking of statistical information only. I think that the fishing industry, although they are very much depressed, no doubt, over the failure of their Fishery Bill, would still be very glad to assist the Government in all ways, and to give information. Certainly that is what I mean. I do not want Mr. Spring-Rice or the Committee to think the other way. No doubt there is a very bad feeling in the trade now, but at the same time they are not averse to still assisting, and picking up the lost ground, if possible. Of course, I myself feel not very much inclined to try and pick up that Sea Fisheries Bill again, because it is a very big undertaking, both for those inside the Government and those outside, and I feel rather more like taking a holiday. I would much rather have an efficient Government Department to co-operate with first.

2910. (*Mr. Crawford.*) Is there anything else you would like to add?—I do not think there is anything more; but, of course, I have not been able to come here with the information as to detail, but that could be left as an after matter. My great object that I had in view in coming was that the Government should not look immediately to scientific research for curing our troubles, but rather to a better organisation of the administrative authority; and I wish to say that scientific research should be a sub-department under that organisation. There seems to be now a tendency to look to scientists, and, as far as I can see, it is not likely to lead to success. I quite admit that scientific research is very necessary, but a responsible administration is much more necessary. Scientists cannot find out things for us unless there is someone to tell them what to find out. Scientific research, as generally understood, would never act quickly enough to save a fishery from extinction or an industry from disaster. The fishing industries would be very willing to assist a competent administrative authority in its work.

APPENDIX.

APPENDIX I.

SCHEME FOR THE INVESTIGATION OF THE IRISH SEA.

DRAWN UP BY PROFESSOR W. A. HERDMAN, F.R.S.

The suggestion, which I have made on several occasions, that a detailed scientific survey of the Irish Sea should be undertaken either by a Central Fisheries Department for England or by the Lancashire District Committee in co-operation with the Irish Fisheries Board is not an alternative to the International scheme, but is independent, and was proposed some years before the Stockholm Conference met. It might form a part of the International scheme, or it might precede that scheme, as being simpler and more likely to lead to a definite conclusion within a reasonable time.

This scheme was first proposed to the Lancashire Sea Fisheries Committee in 1892, and was, in part, printed in my first report to that Committee. It was then adopted, in part, as a portion of the work of the Lancashire Sea Fisheries Committee's steamer, and, as a result of the carrying out of that work by the steamer, during the last eight years, we have now over 1,000 schedules filled up with the details of experimental hauls of fish and shrimp trawls taken in different parts of the district. This series of schedules, although of great importance in connection with the Lancashire fisheries, and full of isolated observations which have their interest and use, is not sufficiently complete as regards dates, and not sufficiently extensive as regards area to afford the system of scientific statistics we require to enable us to discuss the fish and other populations of the Irish Sea.

Consequently in October, 1900, when the Lancashire Committee was arranging the work for the newly-acquired larger steamer I drew up my scheme of investigation afresh with some alterations and additions, and brought it before the Committee. I think I am correct in saying that the Committee approved of the scheme in principle, admitted that some such work was necessary in order to give those reliable scientific statistics the want of which has been so frequently deplored by Select Committees, Conferences and other fisheries meetings, but felt themselves unable to order that the work should be carried out, simply because with a large district extending along about 440 miles of coast they have only one steamer, the first duty of which must be administrative and police work. I consider that the Committee were right in that decision. I agree with them that if one steamer is to carry on all the work of the Lancashire district, and if police work is to be regarded as the first duty, then sufficient time does not remain in which to carry out an adequate programme of scientific investigation. I, therefore, then proceeded to draw up the scheme on the basis that one steamer would be devoted to scientific and statistical work alone in the Irish Sea It would be still better if one such steamer from the Lancashire side could collaborate with another from the Irish Coast. This scheme I submitted in outline to a meeting of a Departmental Committee on Fisheries Statistics at the Board of Trade on 2nd November, 1900. and I now give it here in detail.

I assume that what we stand most in need of at present is full and accurate statistics in regard to our fisheries, and much more detailed information than we have as to the distribution round the coast both of fishes in all stages of growth, and also of the lower animals with which they are associated, and upon which they feed. I consider that what is necessary to give us that information is the nearest approximation we can make to a census of certain parts of our seas, beginning with the territorial waters and those off-shore grounds that supply them, and are definitely related to them. The work would be partly of a statistical nature, and partly scientific observations and investigations, and it seems clear that it is only by such methods that we can hope to settle many important fishery questions. My contention, then, is that such an investigation of our seas must be made, that it is urgent, and should be made as soon as possible, and that the Irish Sea is favourably situated to be made a test-case before undertaking the much wider and more difficult expanse of the North Sea complicated by international questions. The Irish Sea is of moderate and manageable dimensions.* It is all bounded by British territory and by sea fisheries authorities which might agree as to regulations. Its depths and the nature of its bottom deposits are most varied. It is a "self-contained" fish area, containing spawning banks, feeding grounds, and "nurseries." It has several laboratories (Liverpool, Dublin, Port Erin, and Piel) situated on its borders, which would form convenient centres for investigation, and it is controlled by powerful sea-fisheries authorities, two of which, Lancashire and Ireland, might possibly be enabled to combine to carry out the work.

Appendix

In this scheme, then, I suppose that a steamer of the size of a modern steam trawler, equipped with the necessary gear and apparatus, and having at least two scientific men on board, should devote all her time to the exploration of the Irish Sea. Such a vessel would cost about £6,000 to £8,000 to purchase, and the cost of running her would be about £2,000 a year I take the month as the unit of time, and consider that every observing station must be visited twelve times in the year.

If we plan four weekly voyages to different parts of the area in each month, and lay out four days' work in each week, that will allow for occasional days off for coaling, repairs, etc., and will give some extra working time in fine months, which could be devoted to further exploration outside the fixed programme. Bad weather will, no doubt, occasionally interfere, but it may reasonably be expected that in most months it will be possible to work on at least sixteen days.

The two kinds of work should be distinguished:—

1. The systematic statistical work, consisting of trawling and tow-netting along certain fixed lines, always with the same appacatus, on the same ground and at regular intervals. Physical observations and quantitative plankton work would be carried on along with the trawling at each station.

2. General exploration, such as faunistic work, the tracing of areas of the sea bottom, the surveying of spawning and rearing grounds, the determination of the distribution of invertebrata and of fishes. The programme for this work would necessarily be elastic, and could only be undertaken when it did not interfere with the fixed observations under 1.

It is proposed that in each month the first week should be devoted to work in the important waters round the Isle of Man, the second to the deep water off Anglesey, the third to Cardigan Bay and the coast of Wales, and the fourth to the shallow in-shore waters of the Lancashire and Cheshire coasts.

First week.

First Day.—Start from Fleetwood and steam west till the 20 fathom line is reached, about 35 miles. This is the region known as the "Hole," a very important spawning ground for plaice and other flat fish. The

*Its wider area north of Holyhead contains about 10,000 square miles, and is about one-twentieth part of the area of the North Sea.

Appendix

vessel should now take three hauls of the fish trawl, each of two hours duration, along lines running east and west at depths of 20 to 25 fathoms. After the last of these a short haul should also be taken over a part of the same ground with a shrimp trawl, in order to obtain smaller fish and compare results. Plankton nets will also be used simultaneously with the trawl, and physical observations will be taken at the beginning and end of each haul. The vessel will lie for the night in Port St. Mary Harbour.

Second Day.—The vessel will steam south to the deep water lying south and south-west of the Calf Island, which we know to be the spawning ground of cod, hake, haddock, and other fish. Three hauls with the fish trawl and one with the shrimp trawl should be taken along lines running north and south in water of depths of from 30 to 50 fathoms. Plankton nets and physical observations as before. Vessel to lie for night according to weather, in Port St. Mary, Port Erin, or Peel harbours.

Third Day.—The vessel will steam to deep water lying west of Isle of Man, and take two hauls of the fish trawl and one of the shrimp net on the "reamy" ground, where the sole, the turbot, and the brill spawn at depths of 30 to 50 fathoms, and one haul of the fish trawl on the mud at a depth of 70 to 80 fathoms. The vessel will then run further to the north and take two drags in the middle of the channel between Point of Ayre and the Mull of Galloway, at a depth of 20 to 30 fathoms. Plankton and physical observations as before at each station.

Fourth Day.—After spending the night at either Peel or Ramsey, according to the wind, the vessel will trawl from Ayre Point towards St. Bees Head, along the 20 fathom line, and then south from King William's Bank in the muddy depression of over 20 fathoms, and also along the Bahama Bank, off Maughold Head. Two hauls of the fish trawl should be taken at each of these localities. Plankton and physical observations as before.

That finishes the statistical investigation for that week, and the vessel will then, according to circumstances, either return to Fleetwood to land material and refit, or will stay out longer exploring the spawning grounds, etc., and doing other general work under the heading 2 on page 2. (*See* page 129.)

Second Week.

First Day.—Start from Fleetwood and steam south-west to the 20 fathom line opposite the mouth of the Ribble (26 miles), where we have found the tongue of deep water to be a spawning ground for haddock, whiting, etc. Take three hauls from east to west in depths of 20 to 30 fathoms, followed by one or two hauls of shrimp trawl, and run south to Holyhead harbour for night.

Second Day.—Start from Holyhead and trawl north west in depths of 30 to 50 fathoms, so as to make a traverse across the channel by which the tide enters the Lancashire district from the south. Lie at night in Port Erin or Port St. Mary, according to wind.

Third Day.—Steam directly south from Calf Island towards Holyhead, and trawl in depths of 30 to 40 fathoms. Stay night in Holyhead.

Fourth Day.—Leave Holyhead and steam round Skerries to north coast of Anglesey. Take haul along the 20 fathom line towards Point Lynas. Then take two hauls of fish trawl in Red Wharf Bay and one of shrimp trawl, and run into Straits for the night. Any additional time that week could be spent in exploring Red Wharf and Beaumaris Bays and the neighbourhood. Remain week-end in Straits.

Third Week.

First Day.—Steam through Menai Straits to Carnarvon Bay, and spend rest of day in making several traverses of the shallow waters between Anglesey and Bardsey Island. Lie for the night in St. Tudwell Roads.

Second Day.—Continue south into Cardigan Bay, and trawl within the 20 fathom line south to New Quay or Cardigan, staying for the night either in New Quay or Fishguard Bays.

Third Day.—Trawl across St. George's Channel from off St. David's Head to the Tuskar Rock and back, and stay night in Fishguard Bay.

Fourth Day.—Trawl northwards towards Bardsey Island in depths of 30 to 50 fathoms, and steam for night into Menai Straits.

Any additional time this week afforded by good weather can be spent in exploring northern parts of Cardigan and Carnarvon Bays. Stay week end in Straits.

Fourth Week.

Lancashire and Cheshire Inshore Fishing Grounds.

First Day.—Leave Menai Straits, and work from the Great Ormes Head eastwards in the shallow water, within the ten-fathom line, to the mouth of the Dee. Take two hauls of the fish trawl between the Orms and the West Hoyle Bank, and two hauls of the shrimp trawl between the West Hoyle Bank and the Mersey. Stay night at New Brighton.

Second Day.—Take out a fishing boat for the day from New Brighton. Put a man on board her, and set her to work with the shrimp trawl in the shallow channels about Burbo Bank and Crosby Channel. Steamer to go further out and take hauls of fish trawl in Liverpool Bay within the ten-fathom line. Return to New Brighton for night, picking up fishing boat and getting results of day's work.

Third Day.—Steam to Formby Point, and start trawling northwards to Blackpool. Pick up a fishing boat for the day at New Brighton or Southport, put a man on board, and set it working shrimp trawl in the shallow water. Steamer to work outside the banks up to and including the Blackpool closed grounds, upon which one haul of fish trawl and one haul of shrimp trawl should be taken for comparison with hauls immediately before upon ground lying immediately to the south, off the Ribble. Pick up boat and get results, and then run to Fleetwood for night.

Fourth Day.—Leave Fleetwood for Morecambe Bay and Barrow Channel, taking a fishing boat in tow and setting her to work in the shallow water with shrimp trawl, while steamer uses fish trawl further out, as far north as estuary of Duddon, but all inside the 6 or 7 fathoms line.

In evening pick up boat and return to Fleetwood for week end, when general results of month's cruise would be seen to and put in order.

It would be well to send off certain collections when in port at the end of each week to Liverpool or wherever the central laboratory is located.

The lines for trawling along each day are laid down on the accompanying chart, and along each line the same series of observations should be taken.

The observations made should include—

(1) Drags with the fish trawl and shrimp trawl.

(2) Plankton collections with surface and bottom horizontal tow-nets, and also with quantitative vertical nets.

(3) Physical observations with thermometers, hydrometers, water-bottles, etc.

I. Fish and Shrimp Trawling Observations.—(*a*) Drags should be made under strictly uniform conditions—that is, the same trawl net should always be used, and the drags should be of uniform length and duration, in order that they may be as strictly as possible comparable with one another. In addition to the fish trawl, it would be very useful at most stations if a haul of the shrimp trawl could also be taken.

(*b*) Every drag should be recorded, irrespective of the numbers of fish caught. A poor haul is just as important for statistical purposes as a successful one.

(*c*) All the fish caught should be measured, and the numbers of each kind and size accurately recorded on a form similar to the one appended.

(*d*) Two or three individuals of each of the more important kinds of fish—such as plaice, sole, cod, haddock—from every haul should be weighed and measured separately. The ovaries should then be taken out and weighed, and the results recorded on the form. Anything noteworthy in the condition or appearance of the ovaries should also be added. The stomachs should be opened and the contents noted.

(*e*) Mention should be made of any unusual fishes or invertebrata taken in the trawl, and also of any special

abundance of common things such as star-fishes, crabs, molluscs, jellyfish, zoophytes, worms, or other fish food. Unusual specimens, or anything not recognised, should always be preserved for examination in the Liverpool Laboratory.

II. "Plankton" (or Tow-net) Collections.—Tow nettings should be taken along with every drag of the fish trawl. One haul with a bottom and one with a surface net should be made on each occasion. Also one haul of the vertical net for quantitative work should be made at each station. These collections should be at once preserved according to instructions, and sent to the Liverpool Laboratory as soon as convenient after landing. Extra tow-nettings should be taken as frequently as possible. All such observations on the floating life of the sea (which includes the eggs and the microscopic food of many fishes) are most useful. Occasional hauls at particular seasons with a large mid-water net to ascertain the presence of larvæ and young fish would be most useful, but might form a part of the additional exploration work.

III. Physical Observations.—(*a*) Sea Temperatures.—Surface and bottom observations should be taken at the beginning and end of each drag, and should be read to 0·1° C. Bottom temperatures should be taken with a reversing thermometer. At certain stations in deep water, periodically, serial temperatures at 0, 2, 5, 10, 15, 20, 25, 30, 40, 50, 60, and 70 fathoms should be taken.

(*b*) Specific Gravity (density) of the Sea Water.—Surface and bottom observations should be taken at the beginning and end of each drag, and should be read to the fourth place of decimals. Bottom observations should be made on samples of the bottom water, taken with a Mill's bottle. The temperature and specific gravity should be taken simultaneously in the same sample of water. A sample (at least one litre) of the sea water should also be kept and sealed up in a stoppered bottle for examination of the salinity in the laboratory.

(*c*) Air Temperature.—One observation at the beginning of each drag should be taken for comparison with the sea temperature.

(*d*) Barometric Pressure.—One observation taken at the beginning of each drag is sufficient.

(*e*) Transparency and Colour of the Sea Water.—One observation should be taken at the beginning of each drag, and if any notable change has taken place in the water a second observation should be made at the end.

(*f*) Currents.—Drift bottles and other weighted floats should be set free to determine set of tides and other currents.

(*g*) Samples of the bottom deposits should be made and preserved for examination in the laboratory.

(*h*) The state of wind, tide, sea, weather, etc., should be recorded on the form supplied.

The above scheme applies only to the work on board the steamer. The observations at present carried on by the bailiffs in the inshore waters should be continued, and weekly tow-nettings should be taken in each division of the district, and at the Piel and Port Erin Laboratories; and the fullest possible statistics should also be obtained from the commercial fishing fleets.

The forms containing the results of the above observations should be posted to the Fisheries Laboratory, University College, Liverpool, with the least possible delay, as it is important that early information should be obtained of any unusual occurrence or any change in the distribution of fish and plankton throughout the district.

A copy of the form upon which the observations should be recorded is appended.

RECORD OF OBSERVATIONS MADE ON STATION No. _____ Date _____

Position at beginning of drag _____ Position at end of drag _____

Description of net _____

Time net down, beginning of drag _____ end of drag _____

State of tide at beginning of drag _____

Weather _____

Wind _____

Depth during drag, beginning of drag _____ end of drag _____

Nature of bottom _____

General remarks _____

PHYSICAL OBSERVATIONS.

Transparency of water, beginning of drag _____ end of drag _____

Barometer, beginning of drag _____

Air temperature, beginning of drag _____

Surface temperature of water, beginning of drag _____ end of drag _____

Bottom temperature of water, beginning of drag _____ end of drag _____

Specific gravity of surface water, beginning of drag _____ end of drag _____

Specific gravity of bottom water, beginning of drag _____ end of drag _____

General remarks _____

—	No. of fish selected	Size.	Weight.	Wt. of Ovaries.	General condition.
Plaice					
Sole					
Cod					
Haddock					

DESCRIPTION OF CATCH.

Name of Fish.	Size in Inches															Total No.
	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
Sole																	
Plaice																	
Dab																	
Flounder																	
Lemon Sole																	
Cod																	
Whiting																	
Haddock																	
Skate																	
Any other food fishes.																	

Surface tow-netting.—To be filled up in Laboratory.

Bottom tow-netting.—To be filled up in Laboratory.

Note any unusual fishes or invertebrates.

Appendix.

In addition to the regular statistical work planned for 16 days in each month, it is probable that the steamer in most months will be able to devote a few days to the work of exploring outside the stations laid down. Such exploration will be most valuable, both from the purely scientific and the industrial points of view. By such work our knowledge of spawning grounds, "nurseries," and the distribution of the fish in various stages will be advanced, and, moreover, light may be thrown upon the regular statistical observations.

Additional experimental work, such as the use of the large mid-water net, the pumping of water from different depths for plankton estimation, the experimental marking and liberation of fishes, and observations on the vitality of young fishes caught by different methods, might be undertaken on the days left free at the ends of the weeks.

In addition to the captain and crew (say twelve in all) necessary for working the vessel, and accustomed to the use of the trawling and other fishing gear, at least two scientific assistants, the one a chemist or physicist and the other a biologist, should always be on board.

It is obvious that in carrying out this scheme in addition to the work at sea, a considerable amount of work must be done on shore. Probably the most satisfactory and economical method of doing this would be to make use of the existing laboratories at Liverpool, Piel, Port Erin, and, if Ireland joins in the scheme, at Dublin, and to employ the present staff with additions if necessary.

The headings of the work in the laboratories would be as follows:—

1. Tabulation and analysis of the records filled up on steamer.

2. Examination, estimation, and determination of the plankton collected.

3. Examination of the fishes and invertebrates and other material retained as the result of the trawlings.

4. Examination (microscopic and chemical) of the samples of sea bottoms.

5. Physical and chemical work on the sea water. Determination of the densities and salinities of the water samples, and gas analyses of same.

6. Co-relating results of the drift-bottle experiments.

7. Preparation of charts, tables, and reports showing the distribution of animals, and other results.

A short account of the existing organisations carrying on biological work in the Irish Sea is added, because of its important bearing upon any scheme of future work.

I. The Liverpool Marine Biology Committee.—This Committee was founded in 1885 with the object of exploring scientifically the Irish Sea in the neighbourhood of Liverpool. Funds were raised privately amongst the members. The work of the members is entirely voluntary and unpaid, and no Government assistance has been received. For the last fifteen years the Committee have maintained a marine biological station, from 1887 to 1892 at Puffin Island, on the coast of Anglesey, and from 1892 to the present time at Port Erin, in the Isle of Man. Fifteen annual reports of the Committee, five volumes of the "Fauna and Flora of the Irish Sea," and seven memoirs on typical marine animals have now been published. These writings contain a considerable amount of information and other matter bearing on the fisheries of the Irish Sea. The Committee spend about £200 per annum (raised by voluntary contributions) upon their investigations.

An arrangement has recently been completed with the Manx Government, as the result of which a new biological station, combined with a sea-fish hatchery, will immediately be erected at Port Erin.

II. The Lancashire Sea Fisheries Laboratory at Liverpool.—In connection with the Zoological Department of University College, Liverpool, there is a small sea fisheries laboratory. A fisheries assistant (at present Mr. James Johnstone, B.Sc.) and a laboratory man are kept constantly employed, under the direction of Professor Herdman, investigating points that arise in connection with the local fisheries, and annual reports upon the work have been published since 1892.

The chief points connected with the fisheries to which attention has been directed, and on which reports have been published from this laboratory, are as follows:—

The food of fishes, both adult and young, 1892, Report I., p. 10.

The relations between the sole and the solenette, 1892, Report I., p. 16.

The distribution of immature fishes, 1892, Report I., p. 23.

The food, habits, &c. of the shrimp, 1892, Report I., p. 34.

The maturity sizes of fishes, 1893, Report II., p. 18.

The determination of spawning grounds, 1893, Report II., p. 21.

Experiments on vitality of fishes in trawls, 1893, Report II., p. 23.

Distribution of young and adult fish, 1894, Report III., p. 37.

Reproduction of the mussel, 1894, Report III., p. 40.

Reproduction of the cockle, 1894, Report III., p. 44.

Experiments on currents by drift bottles, 1894, Report III., p. 51.

Investigation of oysters and disease, 1895, Report IV., p. 56.

Lectures and demonstrations to fishermen 1896, Report V., p. 3.

Experiments in fish hatching, 1896, Report V., p. 11.

Circulating fisheries exhibition, 1897, Report VI., p. 13.

Plankton investigations, 1897, Report VI., p. 17.

Investigation of iron and copper in oysters, 1898, Report VII., p. 67.

Anatomy and reproduction of the cockle, 1899, Report VIII., p. 34.

Practical classes for fishermen 1900, Report IX., p. 5.

Fish parasites, 1900, Report IX., p. 63.

The circulating fisheries exhibition, which was fitted up in 1897, has during the last four years been on view in public institutions in the following Lancashire towns: Liverpool, Salford, Preston, Bolton, St. Helens, Liverpool again, Piel, and, finally, Barrow, where it is at present. While at Salford it was visited by over 120,000 people.

The practical classes for fishermen have been given both in the Liverpool Laboratory and also at the Piel Hatchery, and are considered locally to be very successful. Ten men, chosen by their fellows, are taken at a time, and these work every day for a fortnight, both forenoon and afternoon. The Technical Instruction Committee of the county of Lancaster allows £5 to each man to pay his travelling and living expenses while attending the class.

III. The Marine Laboratory at Piel.—This laboratory was established in October, 1897, by the Lancashire Sea Fisheries Committee, chiefly for the purpose of carrying on experiments (1) in sea fish hatching, (2) in lobster cultivation, and (3) in the reproduction and growth of the edible mollusca (oysters, mussels, cockles, etc.) The resident curator is Mr. Andrew Scott, who, in addition to the routine work of the hatchery, makes constant investigations into the fauna and the fisheries of the neighbourhood, and has written a valuable report upon fish parasites. In 1900 over 14 millions young fish, mostly pleuronectidæ, were hatched and liberated.

The scientific work of the Lancashire Sea Fisheries has the following organisation:—Honorary director, Professor Herdman; resident assistant at Piel, Mr. Andrew Scott; resident assistant at Liverpool, Mr. James Johnstone. Each of these assistants has a lad under him.

The superintendent of the district, Mr. R. A. Dawson, has under him a staff of 12 fishery officers, and also the crew of the steamer, consisting of a captain and 10 men. In addition to these there are seven assistant fishery officers and certain honorary fishery officers.

The steamer "John Fell" has a gross tonnage of 170, is 114 feet in length over all, has 19 feet of beam, and is 11ft. 6in. in depth.

The publications in connection with the administrative and scientific work of the Lancashire Sea Fisheries Committee are:—

(1) Quarterly reports by the Superintendent, Mr. Dawson.

(2) Annual reports on the work in the laboratory and hatchery, by Prof. Herdman and the assistants.

(3) Sea fisheries memoirs, of which the first, "Oysters and Disease," by Herdman and Boyce, appeared in 1899; and the second, "Fishes and Fisheries of the Irish Sea," by Herdman and Dawson," is now in preparation.

(4) Occasional papers, such as "Report upon the Cockle," by J. Johnstone (1899); "Report on Fish Parasites," by Andrew Scott (1901); "Report on the Plaice," by F. J. Cole and J. Johnstone (now printing).

Conclusion.

The northern area of the Irish Sea, from Liverpool to Holyhead and round the Isle of Man to Cumberland, has probably been more thoroughly worked,

(1) Topographically (as to bottom deposits, currents, etc.),

(2) Zoologically (by the Liverpool Marine Biology Committee),

(3) As to its Fisheries (by the Lancashire Sea Fisheries Committee), and is consequently probably better known in its details than any other area of similar size in British seas.

Appendix

It has, moreover, on its borders the marine laboratories mentioned above, with their staff of workers accustomed to the work and the locality, and hence seems, both from these circumstances and from its physical features, to be marked out as an area in which, with comparatively little new organisation, the proposed scheme of statistical investigations could be carried out, in order to test—

(1) How far it is possible to obtain an accurate statistical knowledge of the populations of a sea area; and

(2) Whether such knowledge leads to conclusions of importance in connection with the fishing industries.

APPENDIX II.

FORM shewing the QUANTITY and the different kinds of FISH caught, the (Handed in by

Name of Vessel.	Date of Landing.	Number of Days Fishing and Number of Hauls.	Cod.	Codling.	Ling.	Saithe.	Haddock.			Whiting.		Turbot.	Halibut.	Brill.	Lemons.	
							Large.	Medium.	Small.	Large.	Small.				Large.	Small.

APPENDIX II.

number of DAYS FISHING, number of HAULS made, and the FISHING GROUNDS visited.
Dr. *T. Wemyss Fulton.*)

Plaice.			Dabs.	Witches.		Megrims.		Conger Eels.	Skates.	Hake.	Gurnards.	Catfish.	Anglers or Monks.	Squid.	Others.	Total Cwts.	Place of Fishing.
Large.	Medium.	Small.		Large.	Small.	Large.	Small.										

Appendix.

APPENDIX III.

LETTER handed in by Dr. *D. Noël Paton.*

(*See* Question 1300.)

5, Belgrave Crescent,
30th November 1901.

My dear Noël Paton,

If we make the natural hypothesis that the "take" is proportional to the surface density ρ (*i.e.*, the number of fish per square mile, say), the equation for the variation of density is then

$$d\rho = -\lambda \rho\, dt, \text{ which gives}$$

$$\frac{d(\log \rho)}{dt} = -\lambda$$

$$*\log \rho = c - \lambda t. \qquad (1)$$

where c is an arbitrary constant.

The equation (1) gives

$$\rho = e^{c-\lambda t} = e^{c} e^{-\lambda t};$$

or

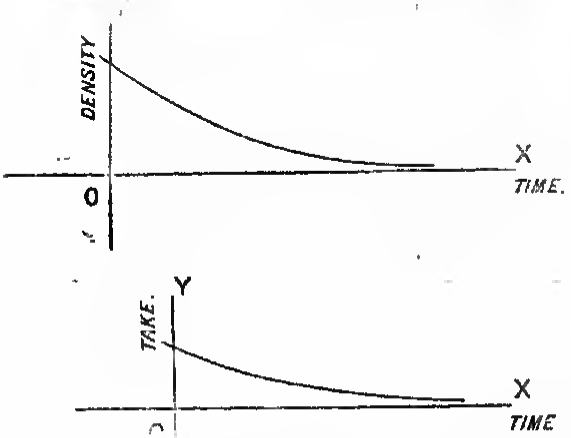
$$\rho = a e^{-\lambda t} \qquad (2)$$

Where a is a constant which we can calculate when we know the surface density of fish at any given epoch.

The take, T, say, of your standard trawler per trawl-mile will then be given by

$$T = \rho \lambda a e^{-\lambda t} \qquad (3)$$

The curves for surface density and take are therefore the same, except that the scales of the ordinates differ.



There is no finite period of extinction, but merely asymptotic approach to extinction, and also, of course, to zero-take.

The above calculation supposes that the fish instantaneously redistribute themselves after disturbance; that nothing is tending either to increase or decrease their number except trawling; and also that the amount of trawling, or the total effect of trawling, is not increasing, either owing to increase of the number of trawlers or improvement of gear.

We may show the effect of the last mentioned cause in a general way by supposing that the amount of trawling increases in arithmetic progression with the time. If we measure time from the epoch at which there was no trawling, this amounts to introducing into the take of the whole fleet a factor proportional to t. The equation for ρ then becomes

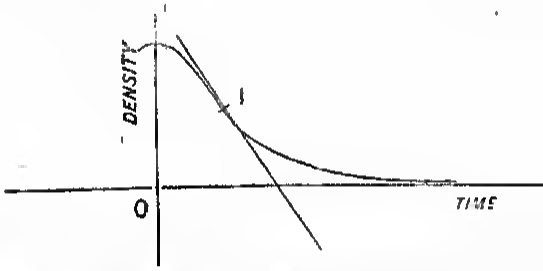
$$\frac{d\rho}{dt} = -\lambda \rho t;$$

$$\text{that is, } \frac{d(\log \rho)}{dt} = -\lambda t.$$

$$\text{Hence } \log \rho = c - \tfrac{1}{2}\lambda t^2;$$

$$\text{or } \rho = a e^{-\frac{1}{2}\lambda t^2}.$$

The density time-curve is now the curve of the "Law of Error." Like this :—

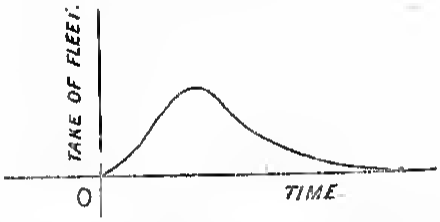


The take T of the whole fleet is $d\rho/dt$, *i.e.*, the gradient (tangent of inclination of tangent to O X) of the curve which begins by being zero, increases to a maximum corresponding to the point of inflexion at I, and then falls asymptotically to zero

The equation would be

$$T = a\lambda t e^{-\frac{1}{2}\lambda t^2};$$

the T-t-curve something like this :—



You will observe that now the take of any particular boat per trawl-mile is not (as time varies) necessarily proportional to the take of the whole fleet. If the increased take of the fleet were due simply to increase of numbers, this would be so; but not so, if the increased take were due wholly or partially to increased efficiency of gear, &c.

There are many questions to be solved, but they do not seem to be beyond the reach of statistics combined with patient and intelligent observation controlled by well-directed special experiments. Hasty conclusions and premature application of formulæ are to be earnestly deprecated. All that mathematics can do at this stage is merely to assist the imagination

Yours, &c.

(signed) G. CHRYSTAL.

* Note that the logarithm of the density, if plotted, would give a straight line.

APPENDIX IV.

List of Tables handed in to the Ichthyological Committee by Mr. *W. E. Archer*, dealing with the experiments made by the "Garland" in the Firth of Forth in the period 1889–1895.

Table I., illustrating the comparability of data.

(*a*) Table showing the dates on which trawlings were made in each year.

(*b*) Table showing the mean day on which each station was trawled over.

(*c*) Table showing the monthly interval between the mean days on which trawlings were made.

(*d*) Table showing the effect of interpolating an assumed figure for those months in which no observations were made—(1) Monthly variations, (2) Yearly variations.

Table II., illustrating the fluctuations in the abundance of fish in different years (accompanying Chart I.):

(*a*) Table showing the average number of Plaice, Common Dabs, Haddock and Whiting caught per mile trawled over in each year.

Table III., illustrating for each station the relation between the highest and lowest haul and the monthly average:

(*a*) Table showing the average monthly number of Plaice, Common Dabs, Haddock and Whiting taken at each station per mile trawled over, and the variation between the highest and lowest haul for each kind of fish in each month (accompanying Chart II.).

(*b*) Table showing the relation between the maximum and minimum quantity of Plaice, Common Dabs, Haddock and Whiting taken in any year, and the average over the whole period (referred to in answer to Question 1539, and accompanying Chart III. and the map of the Firth of Forth).

Table IV., illustrating the size of the Plaice taken at each station:

(*a*) Table showing for each station the average number of Plaice caught per mile trawled over during the period, grouped according to size (accompanying Chart IV.).

Table V., illustrating the annual fluctuations in the quantity of fish taken at different stations. Tables showing for each station the average number of (*a*) Plaice, (*b*) Common Dabs, (*c*) Haddock, (*d*) Whiting caught per mile trawled over in each year (accompanying Chart V.).

Table VI., illustrating the monthly fluctuations in the quantity of fish taken at each station. Tables showing for each station the average number of (*a*) Plaice, (*b*) Common Dabs, (*c*) Haddock, (*d*) Whiting caught per mile trawled over in each month of the year (accompanying Chart VI. (*a*), (*b*), (*c*), (*d*)).

Appendix.

APPENDIX IV.

Tables I.—COMPARABILITY OF DATA.

(*a*) TABLE showing the dates on which Trawlings were made in each Year (referred to in answer to Question 1521).

Station I.	Station II.	Station III.	Station IV.	Station V.	Station VI.	Station VII.	Station VIII.	Station IX.
1889.								
10 Jan.	10 Jan.	7 Jan.	3 Jan.	9 Jan.	9 Jan.	8 Jan.	8 Jan.	8 Jan.
12 Feb.	11 Feb.	5 Feb.	5 Feb.	11 Feb.	11 Feb.	6 Feb.	6 Feb.	6 Feb.
3 Mar.	8 Mar.	11 Mar.	9 Mar.	8 Mar.	8 Mar.	8 Mar.	4 Mar.	4 Mar.
11 April	11 April	3 April	3 April	12 April	12 April	12 April	18 April	18 April
2 May	3 May	2 May	1 May	3 May	3 May	7 May	7 May	7 May
4 June	8 June	3 June	3 June	7 June	7 June	6 June	6 June	6 June
30 July	29 July	30 July	31 July	3 Aug.	3 Aug.	2 Aug.	26 July	26 July
31 Aug.	29 Aug.	30 Aug.	30 Aug.	29 Aug.	29 Aug.	28 Aug.	27 Aug.	27 Aug.
4 Oct.	1 Oct.	3 Oct.	5 Oct.	2 Oct.	1 Oct.	3 Oct.	2 Oct.	2 Oct.
9 Nov.	8 Nov.	11 Nov.	12 Nov.	7 Nov.	7 Nov.	7 Nov.	6 Nov.	6 Nov.
1890.								
12 Feb.	15 Feb.	12 Feb.	13 Feb.	14 Feb.	21 Feb.	13 Feb.	14 Feb.	14 Feb.
17 Mar.	17 Mar.	15 Mar.	13 Mar.	14 Mar.	14 Mar.	1 Mar.	18 Mar.	18 Mar
19 April	23 April	25 April	18 April	25 April	25 April	25 April	24 April	24 April
12 May	12 May	16 May	16 May	15 May	15 May	15 May	13 May	13 May
30 July	30 July	29 July	29 July	31 July	31 July	31 July	5 Aug.	5 Aug.
30 Aug.	28 Aug.	29 Aug.	29 Aug.	3 Sept.	6 Sept.	3 Sept.	4 Sept.	4 Sept.
18 Oct.	15 Oct.	17 Oct.	14 Oct.	20 Oct.	20 Oct.	14 Oct.	13 Oct.	14 Oct.
14 Nov.	15 Nov.	14 Nov.	13 Nov.	19 Nov.	8 Nov.	19 Nov.	2 Dec.	2 Dec.
11 Dec.	12 Dec.	20 Dec.	12 Dec.	17 Dec.	15 Dec.	8 Dec.	—	—
1891.								
15 Jan.	15 Jan.	19 Jan.	24 Jan.	21 Jan.	21 Jan.	12 Jan	29 Jan.	29 Jan.
23 Feb.	24 Feb.	18 Feb.	17 Feb.	20 Feb.	20 Feb.	20 Feb.	19 Feb.	19 Feb.
13 Mar	13 Mar.	14 Mar.	18 Mar.	19 Mar.	21 Mar.	19 Mar.	—	—
15 April	15 April	4 May	4 May	6 May	6 May	5 May	14 April	14 Apr.
23 May	25 May	27 May	26 May	28 May	28 May	27 May	29 May	29 May
22 June	22 June	20 June	18 June	19 June	24 June	23 June	24 June	24 June
15 July	15 July	18 July	17 July	17 July	15 July	16 July	21 July	21 July
14 Aug.	14 Aug.	17 Aug.	15 Aug.	18 Aug.	19 Aug.	17 Aug.	18 Aug.	19 Aug
19 Sept.	19 Sept.	23 Sept.	18 Sept.	1 Oct.	3 Oct.	23 Sept.	24 Sept.	24 Sept.
24 Oct.	23 Oct.	19 Oct.	16 Oct.	22 Oct.	22 Oct.	21 Oct.	30 Oct.	30 Oct.
25 Nov.	21 Nov.	20 Nov.	20 Nov.	24 Nov.	25 Nov.	24 Nov.	23 Nov.	23 Nov.
17 Dec.	17 Dec.	24 Dec	18 Dec.	23 Dec.	23 Dec.	21 Dec.	21 Dec.	22 Dec.

Tables I.—COMPARABILITY OF DATA—*continued.*

(*a*) Table showing the dates on which Trawlings were made in each Year—*continued.*

Station I.	Station II.	Station III.	Station IV.	Station V.	Station VI.	Station VII.	Station VIII.	Station IX.
				1892.				
19 Jan.	19 Jan.	15 Jan.	22 Jan.	21 Jan.	23 Jan.	15 Jan.	14 Jan.	14 Jan.
18 Feb.	18 Feb.	23 Feb.	23 Feb.	24 Feb.	24 Feb.	26 Feb.	19 Feb.	19 Feb.
11 Mar.	10 Mar.	11 Mar.	12 Mar.	16 Mar.	16 Mar.	14 Mar.	16 Mar.	15 Mar.
26 April	21 April	25 April	25 April	2 May	26 April	2 May	9 May	6 May
17 May	19 May	20 May	21 May	18 May	20 May	18 May	25 May	25 May
10 June	10 June	13 June	14 June	13 June	15 June	15 June	9 June	9 June
23 July	20 July	25 July	25 July	22 July	20 July	22 July	21 July	21 July
21 Sept.	21 Sept.	22 Sept.	20 Sept.	14 Sept.	14 Sept.	14 Sept.	13 Sept.	12 Sept.
21 Oct.	22 Oct.	21 Oct.	26 Oct.	24 Oct.	24 Oct.	26 Oct.	25 Oct.	25 Oct.
23 Nov.	23 Nov.	22 Nov.	22 Nov.	24 Nov.	24 Nov.	25 Nov.	2 Dec.	2 Dec.
16 Dec.	22 Dec.	16 Dec.	23 Dec.	19 Dec.	22 Dec.	15 Dec.	20 Dec.	22 Dec.
				1893				
17 Jan.	17 Jan.	16 Jan.	24 Jan.	6 Feb.	20 Jan.	25 Jan.	25 Jan.	18 Jan.
21 Feb.	21 Feb.	20 Feb.	17 Feb.	2 Mar.	2 Mar.	28 Feb.	24 Feb.	24 Feb.
20 Apr.	19 April	19 Apr.	20 April	18 Apr.	18 Apr.	17 Apr.	14 April	14 April
27 May	31 May	24 May	23 May	30 May	31 May	24 May	30 May	2 June
15 June	17 June	16 June	19 June	13 June	19 June	14 June	14 June	14 June
31 July	28 July	31 July	1 Aug.	28 July	28 July	1 Aug.	27 July	27 July
24 Aug.	25 Aug.	24 Aug.	25 Aug.	29 Aug.	30 Aug.	28 Aug.	29 Aug.	29 Aug.
20 Sept	20 Sept.	21 Sept.	22 Sept	18 Sept.	23 Sept.	26 Sept.	18 Sept.	—
25 Oct.	25 Oct.	27 Oct.	24 Oct	31 Oct.	31 Oct.	24 Oct	30 Oct	30 Oct.
15 Nov	16 Nov.	14 Nov.	15 Nov.	27 Nov.	27 Nov.	21 Nov.	—	—
20 Dec	21 Dec.	26 Dec	19 Dec.	28 Dec.	29 Dec.	28 Dec.	27 Dec.	27 Dec.
				1894.				
22 Jan.	26 Jan	–	17 Jan.	—	—	18 Jan.	18 Jan.	19 Jan.
16 Feb.	16 Feb	20 Feb.	15 Feb.	22 Feb.	22 Feb.	23 Feb.	21 Feb.	21 Feb.
20 Mar.	21 Mar.	20 Mar.	21 Mar.	30 Mar.	30 Mar.	29 Mar.	14 Mar.	14 Mar.
15 April	20 April	16 April	13 April	19 April	19 April	13 April	18 April	18 April
22 June	26 June	21 June	21 June	20 June	20 June	20 June	19 June	19 June
24 Aug.	30 Aug.	24 Aug.	23 Aug.	30 Aug.	30 Aug.	23 Aug	29 Aug.	29 Aug.
11 Sept.	11 Sept.	19 Sept.	19 Sept.	13 Sept.	13 Sept.	13 Sept.	12 Sept.	12 Sept
4 Dec.	8 Dec.	10 Dec.	23 Nov.	30 Nov.	30 Nov.	30 Nov.	29 Nov.	28 Nov.
—	26 Dec.	27 Dec.	—	—	—	—	—	—
				1895.				
29 Jan.	29 Jan.	4 Feb	30 Jan.	—	—	—	—	—
26 Feb.	27 Feb.	—	27 Feb.	9 Feb	11 Feb.	11 Feb.	8 Feb	12 Feb.
—	—	—	—	20 Mar.	20 Mar.	19 Mar.	19 Mar.	15 Mar.
17 April	18 April	17 April	16 April	23 April	23 April	19 April	22 April	22 April
22 May	31 May	22 May	21 May	29 May	29 May	28 May	28 May	28 May
17 July	15 July	17 July	18 July	15–16 July	12 July	15 July	16 July	16 July
31 Aug.	29 Aug.	22 Aug.	30 Aug.	29 Aug.	29 Aug.	28 Aug	28 Aug.	28 Aug.
21 Sept.	19 Sept.	24 Sept.	18 Sept.	26 Sept.	28 Sept.	27 Sept.	27 Sept.	27 Sept.
17 Oct.	10 Oct.	11 Oct.	16 Oct.	—	—	18 Oct.	18 Oct	—
14 Dec.	12 Dec.	18 Dec.	11 Dec.	—	—	19 Dec.	20 Dec.	20 Dec.

Appendix.

Appendix IV.—*continued.*

Tables I.—COMPARABILITY OF DATA—*continued.*

(*b*) TABLE showing the MEAN DAY on which each Station was trawled over during 1889–1895 (referred to in answer to Question 1521).

Month.	Station.									Differences between the highest and lowest means.
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	
										Days.
January	19	19	18	20	22	18	16	19	18	6
February	18	19	16	17	19	20	18	16	18	4
March	13	14	14	15	18	18	17	14	13	5
April	18	18	20	18	24	23	22	21	21	6
May	17	20	19	18	21	21	20	22	23	6
June	15	17	15	15	14	17	16	14	14	3
July	24	23	25	25	25	23	25	25	25	2
August	26	26	24	25	28	29	26	28	28	5
September	18	18	22	19	20	23	21	19	19	5
October	18	16	16	17	20	20	18	20	20	4
November	20	20	20	18	22	22	21	24	24	6
December	16	18	22	17	22	22	18	22	23	7

(*c*) TABLE showing the MONTHLY INTERVAL between the MEAN DAYS on which Trawlings were made during 1889–1895 (referred to in answer to Question 1521).

	Station.									Difference between the longest and shortest intervals.
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	
	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.
January to February	31	32	30	20	29	34	34	29	30	5
February to March	24	24	27	27	28	27	28	27	26	4
March to April	37	36	38	35	38	37	37	39	40	5
April to May	30	33	30	31	28	29	29	32	33	5
May to June	30	29	28	29	25	28	28	24	23	7
June to July	40	37	41	41	42	37	40	42	42	6
July to August	34	35	31	32	35	38	33	35	35	7
August to September	24	24	30	26	24	26	27	23	23	7
September to October	31	29	25	29	31	28	28	32	32	7
October to November	34	36	36	33	34	34	35	36	36	3
November to December	27	29	33	30	31	31	28	29	30	6
December to January	35	33	28	35	32	28	30	29	27	8

NOTE.—For the actual dates *see* Table (*a*). Where trawlings have been begun in one month and not completed until early in the next, they have been credited to the month in which the greatest number of stations were trawled.

Tables I.—COMPARABILITY OF DATA—*continued*

(d) TABLE showing the effect of interpolating an assumed figure for those months in which no observations were made (referred to in answers to Questions 1521 to 1532).

MONTHLY VARIATIONS.

MEAN Number of Plaice per Haul

MONTH.	SIZE IN INCHES																				TOTAL.	Mean No. per Mile trawled over
	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	22 +	23 +		
January	—	—	—	3·1	2·1	1·8	12·0	30·0	14·1	41·8	7·0	0·1	4·7	0·3	0·2	—	—	—	—	—	138·0	10·2
	—	—	—	3·2	3·3	1·8	30·9	52·6	15·4	30·5	7·9	0·4	3·3	1·1	0·2	—	—	—	—	—	233·0	27·1
*February	—	—	1·0	0·8	3·2	24·5	30·8	30·1	37·1	27·2	10·8	1·0	1·1	0·1	—	—	—	—	—	—	277·0	30·3
March	1·1	—	0·2	10·3	1·8	10·8	20·8	13·0	44·0	0·8	30·3	0·0	3·2	—	—	—	—	—	—	—	144·8	10·5
	0·1	—	0·1	30·7	0·3	24·5	20·2	60·0	40·3	0·6	24·0	0·7	2·0	—	—	—	—	—	—	—	305·0	31·7
*April	—	0·1	0·0	4·7	10·7	10·8	10·0	41·0	11·8	10·1	—	1·5	—	—	0·1	0·1	—	—	—	0·1	157·9	10·8
May	—	—	—	30·0	—	10·5	91·0	13·5	8·4	5·8	18·0	1·5	—	—	—	—	—	—	0·3	—	90·7	15·0
	—	—	—	12·4	—	10·6	29·8	21·1	4·9	0·1	10·3	1·4	—	—	—	—	—	—	0·1	—	80·6	30·0
June	—	—	2·2	2·8	10·5	10·3	41·8	28·4	20·4	4·4	9·4	0·1	0·2	0·3	0·2	—	—	—	—	—	145·4	19·4
	—	—	2·0	6·0	10·5	10·5	46·5	51·6	29·4	8·4	9·4	0·0	0·1	1·1	0·1	—	—	—	—	—	166·1	30·5
July	—	0·8	2·1	2·0	20·6	10·2	21·8	30·5	30·8	10·4	7·8	2·0	1·5	—	0·0	—	—	—	0·3	—	160·8	11·1
	—	5·9	3·5	6·6	27·7	30·5	30·1	57·7	10·0	23·0	5·0	4·2	2·5	—	0·1	—	—	—	0·4	—	307·0	27·5
August	—	2·0	4·0	14·[illegible]	12·7	7·8	30·0	50·0	42·0	18·0	0·5	0·6	1·0	—	—	0·0	—	—	—	—	180·0	14·7
	—	4·3	4·2	25·0	10·5	7·1	53·5	27·0	20·6	27·6	5·5	0·5	2·0	—	—	0·2	—	—	—	—	275·9	32·[illegible]
September	—	1·0	0·4	18·3	0·1	34·5	10·5	30·3	10·5	0·2	0·2	1·6	—	0·2	—	—	—	—	—	—	137·8	10·5
	—	2·0	0·0	30·2	0·4	30·7	22·0	60·1	13·0	0·0	3·2	1·7	—	0·1	—	—	—	—	—	—	330·4	27·6
October	—	—	0·7	1·8	1·8	13·0	10·5	30·8	30·1	24·0	7·2	1·5	0·3	0·7	—	3·0	0·5	—	—	—	130·3	10·0
	—	—	0·7	3·0	0·3	30·8	32·0	37·7	27·0	32·0	7·0	2·0	0·2	0·7	—	0·1	0·1	—	—	—	190·7	30·9
November	—	—	0·7	9·0	1·6	15·0	30·1	12·6	28·3	20·8	15·8	7·0	0·1	1·9	2·0	2·2	—	0·1	—	—	142·5	10·5
	—	—	0·7	0·4	2·0	30·8	62·1	14·8	30·3	30·7	22·1	7·7	0·0	3·0	0·3	0·2	—	0·1	—	—	239·1	30·8
Season of	—	—	—	1·8	0·8	0·8	10·5	31·0	25·0	30·4	18·0	10·1	0·0	1·9	0·4	1·0	—	—	—	—	180·0	37·4
	—	—	—	2·0	0·8	6·1	31·0	33·0	51·0	30·5	11·6	11·1	0·0	2·3	1·0	0·2	—	—	—	—	144·0	10·0
Mean No. per Haul	0·0	0·7	1·2	0·8	0·8	12·1	17·0	24·3	16·1	16·0	8·7	8·0	1·1	0·4	0·1	0·1	—	0·0	0·3	0·0	149·4	10·5
	0·0	0·7	1·8	0·8	0·4	27·0	29·2	35·7	17·2	30·5	8·8	9·0	1·9	0·5	0·1	0·2	—	0·0	0·0	0·1	310·5	30·0

Figures in italics show result of interpolation
* In this month interpolation was unnecessary

Yearly Variations.

Mean Number of Plaice caught per Haul at Station IV., grouped according to size.

Year.	Size in inches.																			Total.	Mean No. per Mile trawled over
	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	22 +		
1888	—	—	2·5	1·0	0·7	12·6	20·7	23·9	30·3	24·7	20·3	9·7	1·9	—	0·2	—	—	—	—	159·3	26·7
	—	0·1	2·5	2·3	0·2	15·3	31·1	33·7	30·2	25·6	20·3	9·5	1·6	0·2	0·3	—	—	—	—	209·3	35·3
1890	—	0·2	0·1	—	0·2	1·4	3·9	4·1	10·9	17·3	1·9	4·3	1·3	1·4	—	—	—	—	0·1	—	72·1	0·7
	—	0·1	0·2	1·0	0·6	5·2	12·0	6·2	19·5	16·6	4·3	0·2	2·1	2·1	—	—	—	—	0·2	—	71·1	2·5
1891*	—	0·2	0·7	0·2	16·9	20·4	24·1	14·0	19·4	17·4	12·1	0·2	1·9	0·2	0·2	—	—	—	0·2	0·1	161·4	18·1
1892	—	1·2	1·9	0·2	3·4	10·1	13·1	14·0	20·2	10·2	4·5	0·2	0·2	0·3	—	0·1	—	—	—	—	97·1	13·9
	—	1·2	1·2	2·4	2·3	15·3	15·1	15·9	20·1	20·1	1·7	0·2	0·3	0·7	—	0·2	—	—	—	—	97·1	13·9
1893	—	—	2·3	2·5	2·3	12·1	27·6	17·3	10·9	10·9	0·4	1·4	2·4	—	—	0·2	0·1	—	—	—	120·1	16·4
	0·2	—	2·0	2·0	2·6	13·2	28·3	17·7	15·1	27·3	0·2	4·9	2·5	—	—	0·6	0·2	—	—	—	120·2	16·5
1894	1·9	1·9	2·5	10·9	18·1	16·5	25·1	10·3	10·9	0·2	0·2	0·2	0·2	0·2	1·9	—	—	0·1	—	—	201·9	27·9
	0·2	1·9	2·7	2·7	12·1	13·7	27·7	14·9	27·1	14·9	2·9	0·2	0·2	0·3	0·2	0·1	—	0·1	0·1	—	120·2	27·2
1895	—	1·9	1·2	0·2	11·4	10·9	20·3	17·9	10·9	21·4	10·9	0·2	0·2	—	0·2	0·2	—	—	0·1	—	133·1	10·9
	0·2	1·5	1·7	2·1	11·7	10·7	14·4	10·2	20·3	20·3	12·9	2·9	0·7	0·7	0·2	0·3	—	—	0·1	—	120·4	20·
Mean No. per Haul	0·2	0·7	1·9	0·2	6·1	12·2	27·9	24·5	27·9	18·9	0·7	2·9	1·1	0·4	0·1	0·2	—	—	—	—	142·1	19·3
	0·2	0·7	1·2	1·9	8·4	11·3	20·1	21·7	27·6	19·5	3·9	0·2	1·9	1·3	0·1	0·1	—	—	—	—		19

Figures in Italics above result of interpolation.
* In this year interpolation was unnecessary.

Table II.—FLUCTUATIONS IN THE ABUNDANCE OF FISH IN DIFFERENT YEARS.

(Accompanying Chart I.)

TABLE showing the Average Number of Plaice, Common Dabs, Haddock and Whiting caught per Mile trawled over in the Firth of Forth in each Year (referred to in answer to Question 1472).

FISH.	1889.	1890.	1891.	1892.	1893.	1894.	1895.
Plaice	8·76	6·36	7·24	5·90	7·23	7·57	9·05
Common Dabs	4·38	5·93	6·89	6·05	7·79	8·65	7·48
Haddock	3·29	6·47	2·74	5·48	26·87	19·04	19·15
Whiting	3·09	14·44	4·48	3·58	2·21	5·04	4·16

Appendix,

Appendix IV.—*continued.*

Table III.—THE RELATION BETWEEN THE HIGHEST AND LOWEST HAUL, AND THE MONTHLY AVERAGE (referred to in answers to Questions 1533 and 1536).

(*a*) TABLE showing the Average Monthly Number of Plaice, Common Dabs, Haddock and Whiting taken at each Station per Mile trawled over, and the Variation between the Lowest and Highest Haul for each kind of Fish in each Month (accompanying Chart II.).

Month.	Plaice			Common Dabs.			Haddock			Whiting.		
	Average for 7 years, 1889–95	Limits of Variation.		Average for 7 years, 1889–95	Limits of Variation.		Average for 7 years, 1889–95	Limits of Variation		Average for 7 years, 1889–95	Limits of Variation.	
		Lowest Haul.	Highest Haul.		Lowest Haul	Highest Haul.		Lowest Haul	Highest Haul.		Lowest Haul	Highest Haul.
STATION I.												
January	·21	–	·50	2·83	·50	10·00	2 79	–	15·50	11 83	–	69·50
February	·54	–	1·00	2·40	·25	10·50	43	–	1·50	1 82	–	5 00
March	2·50	1·50	4·06	5·20	3 00	10·50	·25	·25	·25	2 60	·50	4·50
April	4·08	1·75	9·25	6·64	·50	14·50	1·29	–	4·00	2 43	·25	5·25
May	7·58	4·00	13·25	6·21	1·25	10·50	1·54	–	5·75	3·00	–	12·50
June	12·25	4·75	21·75	12 60	2·25	31 00	8·05	1·25	12·75	2 75	·50	7·50
July	14·75	10·25	24·25	9·17	3·00	18·25	11·54	·25	35 25	8·42	·25	13·00
August	13·50	3·00	19·25	5·92	2·00	17·00	8 75	·25	23·50	17 00	2·00	42·00
September	12·15	8·25	23·00	19·70	7 25	54·75	13 30	·50	52·00	11·05	–	25·50
October	9·37	1·00	16·50	4·50	·75	12·75	6·29	–	22·75	20·00	·25	48·50
November	·92	·25	1·50	4·00	·75	9·75	·83	–	3·50	0·46	·50	12·00
December	·90	–	3·50	3·15	·50	9·00	2·00	·25	9 75	4·85	·75	10·50
STATION II.												
January	·29	–	·57	·67	–	1·14	1·95	–	7·43	2·29	·29	10·00
February	3·71	–	10·57	1·96	–	4·86	·08	–	·57	–	–	-
March	6·86	3·43	11·71	5·77	·57	11·14	–	–	–	·06	–	·29
April	6·57	3·14	11 43	7·02	2·57	10·14	·73	–	2·86	2·24	–	14·00
May	13·90	3·14	27·14	0·07	-	16·00	1·10	-	3·14	·86	–	1·71
June	16·86	3·43	26·57	17·37	9·14	33·71	0·11	1·43	10·86	1·83	·29	4·57
July	20·62	5·71	36·86	25·70	7·14	73·71	13·81	·57	34·86	7·62	1·71	20·57
August	30·61	10·29	72·86	49·57	22·00	84·86	28·48	2·29	65·14	8·95	1·14	42·00
September	19·31	14·00	28·00	59·20	21·43	101·43	23·60	6·86	61 14	7·54	2·29	18·00
October	25·67	9·43	43·71	38·95	11·14	66·00	21·10	·29	58·86	10·76	1·14	21·71
November	2·43	·29	4·57	6·52	·29	20·86	2·43	–	5·71	4·05	–	11·14
December	2 57	·29	8·66	1·57	·57	3·71	3·90	·29	16·80	5·67	–	21·14
STATION III.												
January	·20	–	·66	2·26	–	9·43	·20	–	·57	5·66	·57	12·14
February	·29	–	86	1 57	–	5·43	·36	–	1·71	2·21	–	5 71
March	1·31	·43	2·43	3·06	1·14	8·43	·11	–	·57	2·60	–	7 71
April	3·24	·57	7·14	5·78	2·29	9·29	3·00	–	20·71	4·29	·43	11·43
May	0·55	1·57	11·71	4·95	·57	10·29	2·81	–	15·43	4·98	1·14	17·43
June	12·37	5·14	24·71	8·77	5·00	12·71	3·74	·14	11·71	1·89	1·00	2 71
July	8·64	4 00	11·71	9·19	2 14	17·00	13·98	–	55·86	9·88	1·71	21 29
August	7·12	·29	10·29	6·69	·29	17·43	20·76	–	71·00	13·05	1·14	28·29
September	3·54	1·57	5·86	8·97	3·29	13·00	9·40	–	27·57	3·63	–	6·29
October	3·07	–	8·43	5·02	·14	12·14	3·69	–	15·00	15·88	2·29	48·71
November	·29	–	·80	3·88	–	9·71	1·17	–	4·43	12·36	·14	43·71
December	·63	–	·86	1·48	·29	4·57	1·98	–	5·29	5·71	1·43	18·71

Appendix IV.—*continued.*

Table III.—THE RELATION BETWEEN THE HIGHEST AND LOWEST HAUL, AND THE MONTHLY AVERAGE—*continued.*

(*a*) TABLE showing the Average Monthly Number of Plaice, Common Dabs, Haddock and Whiting taken at each Station per Mile trawled over, and the Variation, &c.—*continued.*

Month.	Plaice.			Common Dabs.			Haddock.			Whiting.		
	Average for 7 years, 1889-95.	Limits of Variation.		Average for 7 years, 1889-95.	Limits of Variation.		Average for 7 years, 1889-95.	Limits of Variation.		Average for 7 years, 1889-95.	Limits of Variation.	
		Lowest Haul.	Highest Haul.		Lowest Haul.	Highest Haul.		Lowest Haul.	Highest Haul.		Lowest Haul.	Highest Haul.
STATION IV.												
January	16·33	3·07	30·67	·84	·27	2·40	–	–	–	·24	–	·93
February	28·97	10·13	52·27	1·52	·13	4·00	–	–	–	·67	–	4·13
March	20·64	9·20	31·47	1·79	·67	3·73	–	–	–	·03	–	1·20
April	20·97	4·40	42·27	3·18	–	3·27	–	–	–	·10	–	·27
May	11·96	·53	24·27	2·47	–	5·87	·04	–	·13	·36	–	·93
June	19·39	10·27	40·13	4·83	1·33	9·60	6·83	–	32·27	2·48	–	6·93
July	21·40	1·20	44·40	7·87	·93	16·80	·96	–	4·27	1·62	·13	5·73
August	24·67	8·13	52·00	9·91	1·20	29·87	2·69	–	13·73	·58	·13	·93
September	18·32	2·13	26·93	7·39	·13	21·47	2·08	–	9·87	·83	–	1·87
October	16·04	2·13	30·27	3·44	·40	5·87	·04	–	·27	·93	–	3·07
November	18·06	6·80	30·67	5·44	3·20	9·07	–	–	–	1·29	–	5·20
December	17·60	3·73	40·40	4·64	·53	16·00	·03	–	·13	4·59	–	20·00
STATION V.												
January	·45	–	·80	1·35	·20	3·20	6·15	2·60	3·00	3·40	–	7·00
February	·57	–	1·80	1·26	–	4·40	16·46	1·20	96·00	5·00	·60	10·20
March	1·57	·40	4·20	2·27	1·00	4·40	8·03	1·80	34·00	3·37	·20	7·00
April	1·91	·40	4·60	1·69	·20	3·40	16·49	1·00	86·40	5·23	1·60	14·20
May	2·90	1·00	5·00	1·13	·20	2·40	10·67	1·80	30·00	2·37	·20	5·80
June	3·83	1·80	5·40	2·52	60	5·80	28·76	–	100·00	2·03	·20	6·80
July	5·60	1·00	13·60	8·07	·40	6·40	73·13	24·40	171·20	4·50	1·80	10·20
August	5·67	3·80	11·40	2·87	·40	4·80	63·77	5·00	125·80	7·03	1·00	23·60
September	5·04	·20	8·60	5·16	·80	8·60	47·76	1·00	94·00	8·76	1·60	17·00
October	6·44	·40	11·80	3·60	·20	8·60	31·00	4·20	85·40	11·88	1·00	24·80
November	1·53	–	4·60	3·63	·20	9·40	13·33	·20	50·00	4·97	·20	14·40
December	·75	·40	1·00	4·00	·20	13·40	16·05	·00	39·40	7·05	·80	22·20
STATION VI.												
January	21·80	1·14	44·57	2·00	–	4·57	1·29	–	4·00	1·00	–	1·71
February	21·55	2·86	38·29	2·69	–	6·71	2·12	–	9·14	·73	–	1·71
March	20·48	9·14	40·00	4·86	2·29	12·00	·48	–	2·29	·67	–	2·29
April	10·61	3·43	21·14	3·10	1·71	4·57	·65	–	2·29	1·06	–	4·57
May	13·05	8·00	15·43	5·52	·57	12·00	1·32	–	4·00	1·24	–	5·14
June	7·77	6·20	10·29	10·51	1·71	22·20	8·57	–	32·57	6·97	–	21·14
July	15·71	2·86	39·43	15·33	3·43	32·00	14·57	1·14	48·57	10·00	·57	22·86
August	20·00	4·57	51·43	16·76	5·71	32·57	17·24	–	77·71	4·67	·57	13·71
September	32·46	5·14	53·14	30·51	10·86	66·86	10·29	–	24·00	5·03	–	14·86
October	35·43	9·14	52·57	15·43	10·29	28·00	9·37	–	24·00	16·00	–	49·14
November	42·67	6·00	72·57	11·71	1·71	28·57	1·62	–	3·43	2·67	–	9·71
December	17·00	6·14	30·86	6·71	2·29	17·14	3·86	–	14·86	2·14	–	7·43

Appendix.

Appendix IV.—*continued.*

Table III.—THE RELATION BETWEEN THE HIGHEST AND LOWEST HAUL, AND THE MONTHLY AVERAGE—*continued.*

(*a*) TABLE showing the Average Monthly Number of Plaice, Common Dabs, Haddock and Whiting taken at each Station per Mile trawled over, and the Variation, &c.—*continued.*

Month.	Plaice.			Common Dabs.			Haddock.			Whiting.		
	Average for 7 years, 1889-95.	Limits of Variation.		Average for 7 years, 1889-95.	Limits of Variation.		Average for 7 years, 1889-95.	Limits of Variation		Average for 7 years, 1889-95	Limits of Variation.	
		Lowest Haul.	Highest Haul.		Lowest Haul.	Highest Haul.		Lowest Haul.	Highest Haul.		Lowest Haul.	Highest Haul.
STATION VII.												
January	·53	–	1·33	·89	·22	1·78	5·60	–	10·89	3·38	·44	6·89
February	·89	·22	2·22	1·17	–	4·89	10·19	–	62·00	2·25	·22	6·67
March	3·41	·67	8·89	5·56	–	16·89	2·44	·22	8·44	1·63	–	3·56
April	3·21	–	7·56	7·56	–	14·89	6·70	–	32·22	1·05	–	2·89
May	7·96	2·44	16·67	16·30	3·11	32·44	6·78	·89	13·78	6·11	·22	32·22
June	7·87	4·89	13·33	19·24	10·44	25·78	16·31	1·11	32·44	2·22	·44	7·33
July	8·41	5·56	13·11	41·04	22·67	53·33	67·15	·22	176·89	8·63	1·33	20·67
August	5·41	·22	12·67	42·96	–	111·78	86·85	–	296·22	9·15	·89	16·00
September	3·51	1·56	7·33	32·89	6·89	62·89	42·04	11·78	123·11	6·27	1·56	17·56
October	3·78	1·33	9·33	16·30	2·22	49·33	50·30	2·44	126·44	17·85	3·11	49·33
November	·56	·22	1·11	3·52	·44	10·89	17·70	·89	62·44	9·00	·44	40·00
December	·27	–	·44	1·42	–	5·11	12·62	–	24·00	10·84	1·11	42·89
STATION VIII.												
January	·16	–	·40	1·28	·60	2·40	6·36	1·00	17·00	7·88	–	32·00
February	·26	–	·80	·94	–	2·60	6·60	1·20	18·65	1·46	·20	3·40
March	·20	–	·40	1·40	·40	2·80	3·84	20	8·60	2·50	·20	7·20
April	·57	20	1·00	4·20	·20	8·40	10·80	1·00	40·80	3·74	·80	6·80
May	·57	–	1·20	2·87	–	8·00	3·57	·20	10·20	2·30	·20	7·00
June	·92	·40	1·60	2·52	·60	4·00	6·88	2·40	15·60	1·52	–	3·80
July	1·30	·20	2·60	4·67	·40	10·00	19·30	1·80	40·80	8·73	1·20	23·20
August	1·66	·20	5·00	6·40	1·80	15·20	45·33	4·00	147·20	17·27	2·40	70·40
September	·88	–	2·20	5·00	–	8·80	38·12	40	100·00	3·32	–	9·60
October	·83	·40	1·00	3·23	·60	6·40	14·57	1·00	30·20	24·13	·20	130·20
November	·32	–	·80	3·44	·20	8·80	6·20	·80	12·40	4·04	1·00	8·40
December	·10	–	20	·80	·40	1·20	9·90	·20	16·80	3·65	–	12·40
STATION IX.												
January	·04	–	·18	1·24	–	2·55	8·36	·73	24·55	2·15	·18	5·09
February	·16	–	·55	2·23	·55	5·82	17·97	·55	67·64	2·70	1·09	6·19
March	·25	–	·55	2·04	1·09	3·45	8·89	·18	14·56	1·64	·18	4·91
April	·13	–	·55	0·75	–	1·64	2·88	–	8·18	3·55	·36	9·45
May	·18	–	·36	1·21	·18	2·73	7·27	·55	23·45	2·36	·36	4·73
June	·15	–	·36	1·13	–	3·27	14·40	–	42·91	1·35	–	2·55
July	·03	–	·18	0·94	·18	2·18	9·18	1·27	25·45	3·18	·36	8·91
August	·45	–	·91	1·04	–	4·91	35·79	–	137·45	12·21	–	40·55
September	·41	–	·73	2·27	·55	5·27	20·14	·18	34·56	5·73	–	13·64
October	1·56	–	3·62	5·33	–	19·27	5·02	–	12·73	11·05	–	49·62
November	·25	–	·36	7·89	–	25·27	6·87	–	18·18	3·53	–	9·09
December	–	–	–	2·30	·36	6·91	8·27	–	22·91	1·59	·73	2·91

Table III.—THE RELATION BETWEEN THE HIGHEST AND LOWEST HAUL, AND THE MONTHLY AVERAGE—*continued.*

(b) TABLE showing the relation between the Maximum and Minimum Quantity of Plaice, Common Dabs, Haddock, and Whiting taken in any Year, and the Average over the whole period (referred to in answer to Question 1539).

Station.	Average for 7 Years, 1889–1895.	Limits of Variation.		Average for 7 Years, 1889–1895.	Limits of Variation.	
		Minimum.	Maximum.		Minimum.	Maximum.
	PLAICE.			COMMON DABS.		
I.	6·48	5·12	7·60	6·61	2·56	10·27
II	12·18	5·91	18·77	17·90	10·63	25·95
III.	3·88	2·24	6·03	5·28	3·04	7·61
IV.	19·79	9·75	30·51	4·37	2·21	0·15
V.	3·02	1·06	4·22	2·63	1·49	4·13
VI.	21·35	10·80	27·26	10·19	6·61	14·94
VII.	3·81	3·02	5·38	15·53	6·57	25·75
VIII.	0·67	0·36	0·94	3·14	1·56	5·17
IX.	0·29	0·09	0·56	2·40	·83	4·00
	HADDOCK.			WHITING.		
I.	4·69	·61	15·14	7·06	4·36	12·56
II.	8·32	2·26	24·06	4·28	1·01	9·40
III.	5·17	—	23·77	7·04	1·75	18·81
IV.	·96	—	4·01	1·09	·23	2·31
V.	28·37	5·77	81·31	5·38	2·07	9·98
VI.	5·88	·57	17·56	4·19	·90	10·54
VII.	26·98	2·82	79·88	6·27	2·00	23·06
VIII.	14·40	3·45	34·72	6·72	2·04	32·00
IX.	11·78	1·19	32·59	4·26	1·44	15·14

Table IV.—SIZE OF THE PLAICE TAKEN AT EACH STATION.

TABLE showing for each Station the Average Number of Plaice caught per Mile trawled over during 1889–1895 grouped according to size (accompanying Chart IV., referred to in answer to Question 1543)

Station.	SIZE IN INCHES																			Station.
	4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+	18+	19+	20+	21+	22+	23+	
I.	–	–	·04	11	10	·65	·73	1·06	1·02	1·09	·85	·30	·04	·06	–	–	–	–	·01	–	I.
II	–	·01	·08	·25	·47	1·63	1·49	2·04	2·97	1·50	1·08	·65	·08	·03	·02	·01	·00	·01	·02	–	II
III.	–	–	·00	·04	·01	·25	71	·63	1 10	58	25	·09	·02	·00	·00	·00	–	–	–	·00	III
IV	·02	·09	·25	·80	1·13	2·20	3·72	2·09	3·66	2·43	1·20	52	15	·05	·02	·01	·00	·00	·01	·00	IV
V.	–	·05	·00	·02	·02	·04	·08	15	·46	·71	52	54	·27	11	·05	·02	·01	·01	·01	·00	V.
VI.	–	–	–	·01	·03	·10	·01	1·01	2·06	3·33	3 10	3·41	1·05	1 33	·45	·20	·20	·26	·17	·08	VI
VII.	–	–	·01	·02	·08	·26	·02	39	·75	92	44	·28	·16	·06	·06	·02	·02	·01	·01	–	VII.
VIII.	–	–	·00	·01	·01	·08	·01	·05	·07	15	·09	·05	·06	·03	·01	·01	·01	·02	·02	–	VIII.
IX.	–	–	–	·00	–	–	·00	·01	·03	·00	·05	·05	·05	·02	·01	·01	·00	·01	·00	–	IX.
All Stations	·00	·00	·03	18	·30	·60	1·07	1·08	2·45	1·05	·73	·43	18	·09	·04	·02	·01	·03	·01	·00	All Stations

Appendix IV.—*continued.*

Tables V.—ANNUAL FLUCTUATIONS IN THE QUANTITY OF FISH TAKEN AT DIFFERENT STATIONS.

TABLE showing for each Station the Average Number of Plaice, Common Dabs, Haddock and Whiting caught in the Firth of Forth per Mile trawled over in each Year (1889–1895), (accompanying Chart V. (*a*), (*b*), (*c*), and (*d*), referred to in answers to Questions 1561 to 1565).

Station.	1889.	1890.	1891.	1892.	1893.	1894.	1895.
			(*a*) PLAICE.				
I.	7·60	7·40	5·80	6·77	6·12	5·12	6·50
II.	16·14	16·77	15·57	11·29	7·29	5·91	10·06
III.	5·23	3·76	2·24	2·53	6·03	3·07	4·49
IV.	25·71	9·75	18·86	12·95	16·39	27·15	30·50
V.	1·60	4·22	6·16	2·42	4·16	3·34	2·06
VI.	21·49	10·60	21·83	27·26	26·46	13·71	11·31
VII.	3·02	3·42	3·62	3·29	4·16	3·96	5·38
VIII.	·86	·38	·70	·36	·80	·94	·66
IX.	·56	·31	·42	·09	·24	·18	·20
All Stations	8·76	6·36	7·24	5·90	7·23	7·57	9·05
			(*b*) COMMON DABS.				
I.	4·10	2·56	10·04	10·27	6·93	5·59	4·92
II.	10·63	19·06	17·57	16·96	25·95	10·51	17·04
III.	3·04	3·62	5·35	5·55	6·26	7·61	5·82
IV.	5·64	2·21	4·49	2·75	4·42	5·20	6·15
V.	1·62	4·13	2·28	1·49	3·09	3·51	2·01
VI.	7·66	9·08	10·14	10·08	12·83	14·04	6·61
VII.	6·67	12·99	13·78	14·93	16·65	25·75	20·57
VIII.	2·56	5·17	2·98	1·56	3·16	3·82	3·44
IX.	1·35	3·23	3·57	0·83	1·52	4·06	2·16
All Stations	4·38	5·93	6·39	6·05	7·79	8·65	7·43

Appendix

Appendix IV.—*continued.*

Table V.—ANNUAL FLUCTUATIONS IN THE QUANTITY OF FISH TAKEN AT DIFFERENT STATIONS—*continued.*

TABLE showing for each Station the Average Number of Plaice, Common Dabs, Haddock and Whiting caught in the Firth of Forth per Mile trawled over in each Year (1889–1895)—*continued.*

Station.	1889.	1890.	1891.	1892.	1893.	1894.	1895.
(c) HADDOCK.							
I.	1·10	·67	1·65	·61	8·57	6·75	15·14
II.	2·26	4·03	4·50	4·08	10·57	11·14	24·06
III.	·24	—	·71	·66	9·77	5·11	23·77
IV.	—	·06	·01	·02	4·01	·47	2·03
V.	9·76	16·40	5·77	14·29	54·38	31·31	37·37
VI.	4·63	5·97	·57	3·06	17·56	4·16	4·41
VII.	2·82	20·89	6·54	12·57	79·68	24·39	39·75
VIII.	6·30	10·20	3·45	6·71	34·72	21·95	18·20
IX.	5·24	5·39	1·19	7·50	32·59	24·25	10·93
All Stations	3·29	6·47	2·74	5·48	26·87	19·04	19·15
(d) WHITING.							
I.	5·48	12·56	8·77	5·98	4·36	6·94	10·44
II.	1·83	9·40	4·98	2·65	1·01	7·59	3·65
III.	3·80	18·81	7·77	4·14	1·75	5·57	9·46
IV.	·23	1·57	2·31	1·19	1·08	·63	·24
V.	4·04	9·96	3·90	6·66	2·07	9·71	2·77
VI.	5·54	10·54	3·05	1·09	3·90	4·65	·90
VII.	2·00	23·06	5·87	2·79	3·29	4·78	3·98
VIII.	4·14	32·00	2·04	5·02	2·40	3·68	2·42
IX.	3·49	15·14	1·44	2·35	2·06	4·98	2·59
All Stations	3·00	14·44	4·48	3·58	2·21	5·04	4·16

Tables VI.—MONTHLY FLUCTUATIONS IN THE QUANTITY OF FISH TAKEN AT EACH STATION.

TABLE showing for each Station the Average Number of Plaice, Common Dabs, Haddock and Whiting caught in the Firth of Forth per Mile trawled over in each month of the Year during 1889–1895 (accompanying Chart VI. (*a*), (*b*), (*c*), and (*d*), referred to in answers to Questions 1566–1567).

Stations.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
					(*a*) PLAICE.							
I.	·21	·54	2·50	4·68	7·38	12·25	14·75	13·50	12·15	9·37	·92	·90
II.	·29	3·71	6·86	6·67	13·90	10·86	20·02	30·81	19·31	25·67	2·43	2·57
III.	·20	·20	1·31	3·24	6·55	12·87	8·64	7·12	3·54	3·07	·20	·33
IV.	16·83	28·97	20·64	20·97	11·96	19·39	21·40	24·67	18·82	16·04	18·96	17·60
V.	·45	·57	1·57	1·91	2·90	3·88	5·60	5·67	5·04	6·44	1·53	·75
VI.	21·86	21·55	20·48	10·61	13·05	7·77	15·71	20·00	32·46	35·43	42·67	17·00
VII.	·53	·89	3·41	3·21	7·96	7·87	6·41	5·41	3·51	3·78	·56	·27
VIII.	·16	·26	·20	·57	·57	·92	1·30	1·66	·88	·83	·32	·10
IX.	·04	·16	·25	·13	·18	·15	·03	·45	·41	1·56	·25	–
All Stations	4·10	0·57	5·90	6·12	6·66	9·46	10·34	11·32	8·97	9·01	5·80	4·19
					(*b*) COMMON DABS.							
I.	2·83	2·46	5·20	6·64	6·21	12·60	9·17	5·92	19·70	4·50	4·00	3·15
II.	0·67	1·96	5·77	7·02	9·67	17·37	25·76	49·57	59·20	38·95	6·52	1·57
III.	2·26	1·57	3·06	5·78	4·95	8·77	9·19	8·69	8·97	5·02	6·88	1·48
IV.	0·84	1·52	1·79	3·16	2·47	4·83	7·87	9·91	7·59	3·44	5·44	4·64
V.	1·35	1·26	2·27	1·69	1·15	2·52	3·07	2·87	5·16	3·60	3·63	4·00
VI.	2·00	2·69	4·80	6·10	6·52	10·51	15·33	16·76	30·51	15·43	11·71	6·71
VII.	0·89	1·17	5·56	7·56	16·30	19·24	41·04	42·96	32·89	16·30	3·52	1·42
VIII.	1·28	0·94	1·40	4·20	2·87	2·52	4·67	6·40	5·00	6·26	3·44	0·80
IX.	1·24	2·23	2·04	0·75	1·21	1·16	0·94	1·64	2·27	6·33	7·89	2·50
All Stations	1·44	1·66	3·21	4·31	5·06	7·89	11·55	13·05	15·62	6·90	5·04	2·65

Appendix.

Appendix IV.—*continued.*

Tables VI.—MONTHLY FLUCTUATIONS IN THE QUANTITY OF FISH TAKEN AT EACH STATION—*continued.*

TABLE showing for each Station the Average Number of Plaice Common Dabs, Haddock and Whiting caught in the Firth of Forth per Mile trawled over in each month of the Year during 1889–1895—*continued.*

Stations.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
(c) HADDOCK.												
I.	2·79	·43	·23	1·29	1 54	8·65	11·54	6·75	13·80	6·29	·83	2·90
II.	1 95	·08	—	·73	1·10	6·11	13·81	28 48	23·60	21·10	2 43	3 90
III.	·20	·36	·11	3·00	2·61	3·74	13 98	20·76	9·40	3 69	1·17	1·98
IV.	—	—	—	—	·04	6·83	·96	2·69	2·08	·04	—	·03
V.	6·15	16·46	8 08	16·49	10·67	28·76	73·13	63·77	47·76	31 00	18·33	16·05
VI.	1·29	2·12	·43	·65	1·52	8·57	14·57	17·24	10·29	9 37	1·62	3·86
VII.	5·60	10·10	2·44	6·70	6·78	16·31	67·15	86·85	42 04	50·30	17·70	12·62
VIII.	6·36	6·60	3·64	10·80	3·57	6·88	19·30	45·33	38·12	14·57	6·20	9·90
IX.	8·36	17·97	3 89	2·88	7·27	14·40	9·18	35·79	20·14	5·02	6 87	6·27
All Stations	3·36	6·27	2·28	4·85	3·98	10·05	23·77	33·45	22·10	14·15	5 09	5·83
(d) WHITING.												
I.	11·83	1·82	2·60	2·43	3·00	2·75	8·42	17·00	11·05	20·00	6·46	4·85
II.	2·29	—	·06	2·24	·86	1·83	7·62	8·95	7·54	10·76	4·05	5·67
III.	5 86	2·21	2·89	4·29	4·98	1·89	9·88	13·05	3·63	15·88	12·36	5·71
IV.	·24	·67	·03	·10	·36	2 48	1·62	·58	·83	·93	1·29	4·59
V.	3·40	5·00	3·37	5·23	2·37	2·08	4·50	7 03	8·76	11·88	4·97	7·05
VI.	1·00	·73	·67	1·06	1·24	6·97	10·00	4 67	5·03	16·00	2·67	2·14
VII.	3·36	2·25	1·63	1·05	6·11	2·22	6·63	9·15	6·27	17·85	9·00	10 84
VIII.	7·88	1·46	2·56	3·74	2·30	1·52	6·73	17 27	3·32	24·13	4·04	3·65
IX.	2·15	2·70	1·64	3·35	2·36	1·35	3·18	12·21	5·73	11·05	3·53	1·59
All Stations	4·21	1·97	1 85	2·70	2·71	2·21	6·00	9·90	5·27	13·43	5·69	5·36

APPENDIX V

SCHEME for Hydrographic Investigations in North Sea suggested by Captain TIZARD, R.N., Assistant Hydrographer (see Question 2163).

Suggestions as to the way in which the hydrographic work in the North Sea, required by the International Conference, can be executed.

The physical condition of the North Sea in the months of February, May, August, and November can, I think, be fairly well ascertained if the sectional lines shown in red on the attached chart of the North Sea be obtained nearly simultaneously in those months.

(a) These lines are:—

1. Deer Ness in Orkneys to Scudasness in Norway, 250 miles.
2. Naze of Norway to Hantsholmen, 70 miles.
3. Aberdeen to Hantsholmen, 340 miles.
4. Flamborough Head to Blaavand, 290 miles.
5. Yarmouth to Hook of Holland, 95 miles.
6. Dover to a point west of Calais, 18 miles.

On each line the depth, temperature of the surface water, temperature of the bottom water, nature of bottom, specimens of bottom, specimens of bottom and surface water, and temperature of the air should be obtained every ten miles.

To obtain these sectional lines two vessels would be required—one vessel for the first three lines, and the other for the last three.

If ships with a speed of ten knots were available, and the weather was fine, the time occupied would not be very great, as the sounding, and all the data mentioned above, should not occupy more than a quarter of an hour for each station.

Taking this as an estimate, the times occupied would be:—

For 1st line, say,		32	hours.	
,, 2nd	,,	9	,,	
,, 3rd	,,	43	,,	
		84	,,	3½ days.
,, 4th	,,	36	,,	
,, 5th	,,	12	,,	
,, 6th	,,	3	,,	
		51	,,	2¼ days.

This calculation is based on the supposition that the observations could be obtained continuously night and day. This, however, in practice, would probably not be found possible. It would be much better to get the results only by daylight, which would about double the times given. Even then, however, it will be seen that, provided the weather was fine, two steamers could get the sectional lines in a week.

Other observations suggested by the Swedish Conference were serial temperature sounding, current observations, dredging, and trawling, etc.

(b) How often the serial temperature observations would be necessary must depend upon the results obtained, but a fair idea could be got of the temperatures, between the surface and the bottom, if they were taken at a quarter, a half, and three quarters of the distance across from one side to the other. This would not occupy any great time, say, two additional hours for each section.

(c) With respect to current and tidal observations, these would occupy a considerable time, as to get satisfactory results the ship must be at anchor, and remain for at least twelve hours for each depth it is desired to obtain the results at.

The surface current would require twelve hours to ascertain how it was affected by tidal influence, but at each depth below the surface a current meter would have to be employed, and this can only be used at one depth at a time.

This operation could only be carried on in the very finest weather.

(d) Trawling and dredging operations would also require considerable time, and it is impossible to give an idea of what biologists would consider a fair time to devote to these investigations.

(e) I would, however, suggest the following plan for consideration:—

If two vessels steaming ten knots could be hired each year for the months of February, May, August, and November, it should be considered their first duty to obtain the sectional lines and temperature observations sketched out in paragraphs (a) and (b).

The rest of the month to be devoted to the observations required by paragraphs (c) and (d), according to the state of the weather and the value of the results.

The cost of getting suitable vessels cannot be decidedly stated, but an idea may be formed from the experience obtained by the Admiralty in hiring a vessel annually for the work of the survey on the West Coast of England. The hire of a suitable Liverpool tug for this purpose is at the rate of about £200 per month for seven months. The total cost to the Admiralty, including wages, coal, and all expenditure for officers and crew, is about £800 per month. If two steamers could be got at this rate, the total cost of each steamer would be £3,200 for the four months, or for both vessels about £6,400 per annum.

T. H. TIZARD.

Hydrographic Department, Admiralty,
February 4th, 1902.

Appendix.

APPENDIX VI.

Form of Return obtained from German Fishermen, showing daily record of fish taken, methods of capture &c.

(Handed in by Dr. *J. T. Jenkins*. See Question 2240.)

FISHING.

STATION_____

YEAR_____

MONTH_____

OBSERVER_____

Month.	Number of Vessels engaged in Fishing with				Catch, kind and quality.				*Notes.*—Particulars as to the average size and quality of each species of fish, and especially as to whether the catch shows any alteration in this respect. Commencement and end of catch of each species of fish. Presence of rare fishes, and injurious or useful (i.e., affording nutriment to the fish) animals. List of fishing tackle, &c.
	Large Net.	Hook.			Herrings.				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									

If fishing for any particular kind of fish has been carried on unsuccessfully, the figure 0 should be placed in the space provided for it above.

If a boat fishes with two kinds of tackle, it should be entered only once and a note made to show what kind of subsidiary tackle was used.

If it cannot be ascertained by what vessels a catch was made, a line should be drawn connecting the catch with the boats concerned.

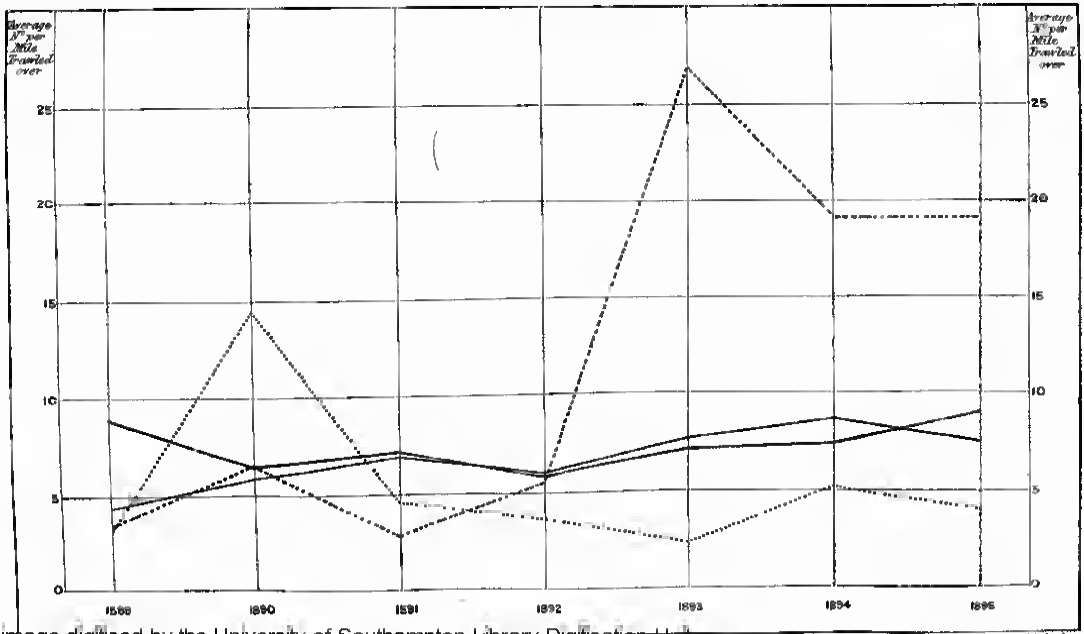
If, owing to any circumstances, information as to the catch on a particular day cannot be obtained, the words "unknown to me" are to be written against that particular date.

INDEX.

SHOWING THE FLUCTUATIONS IN THE ABUNDANCE OF FISH
IN THE FIRTH OF FORTH IN DIFFERENT YEARS.

To illustrate answer to question, 1912.

PLAICE ——— HADDOCK ·····
COMMON DABS ——— WHITING ·····



E. Weller & Graham, Inf. Lith., London.

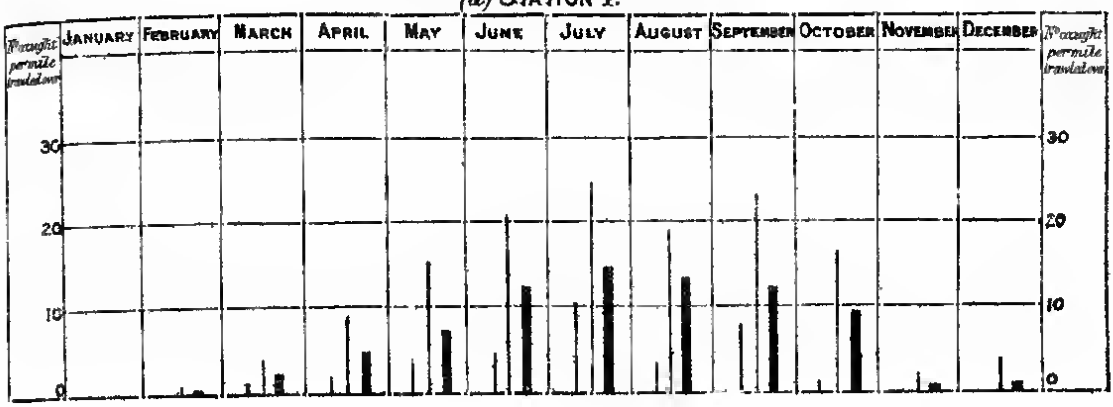
CHART II.

SHOWING THE AVERAGE MONTHLY NUMBER OF PLAICE TAKEN AT EACH STATION IN THE FIRTH OF FORTH (1889–1895) PER MILE TRAWLED OVER AND THE VARIATION BETWEEN THE HIGHEST AND LOWEST HAUL IN EACH MONTH.

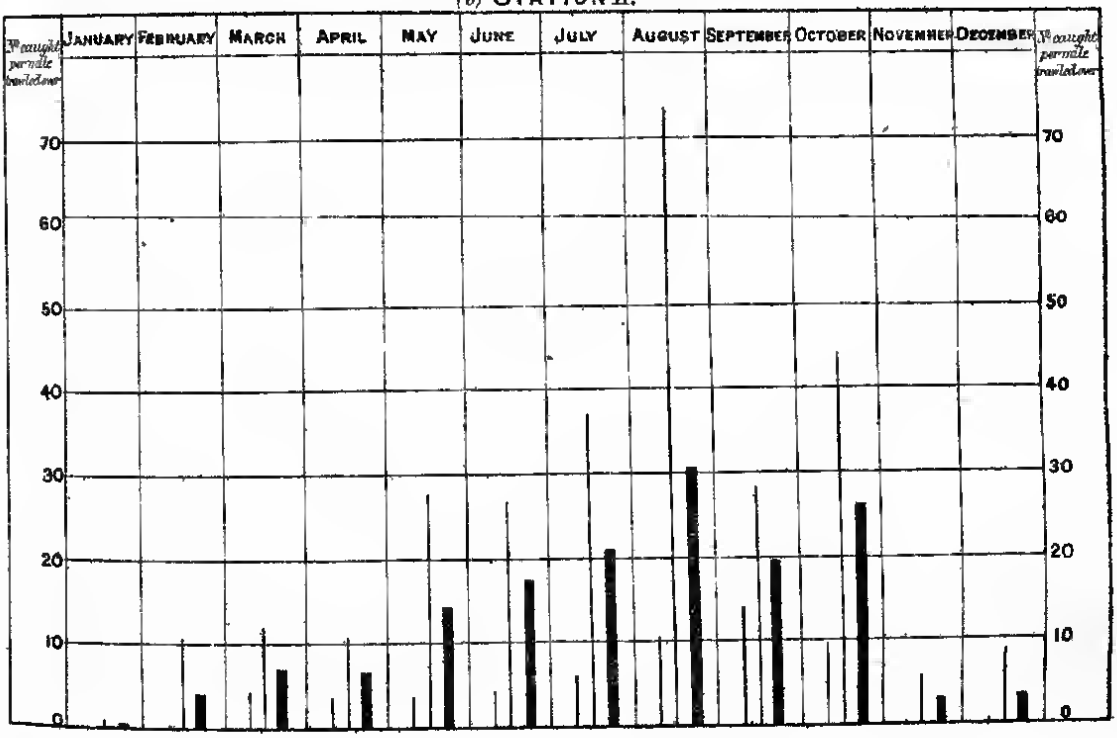
To illustrate answers to questions 1533 to 1537.

Thick lines = Average 1889–1895.
Thin lines = Limits of Variation.

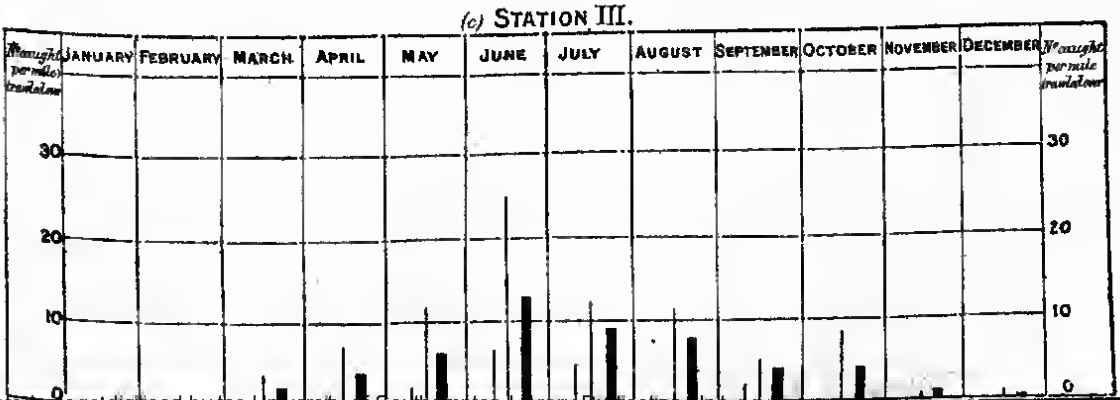
(a) STATION I.



(b) STATION II.



(c) STATION III.

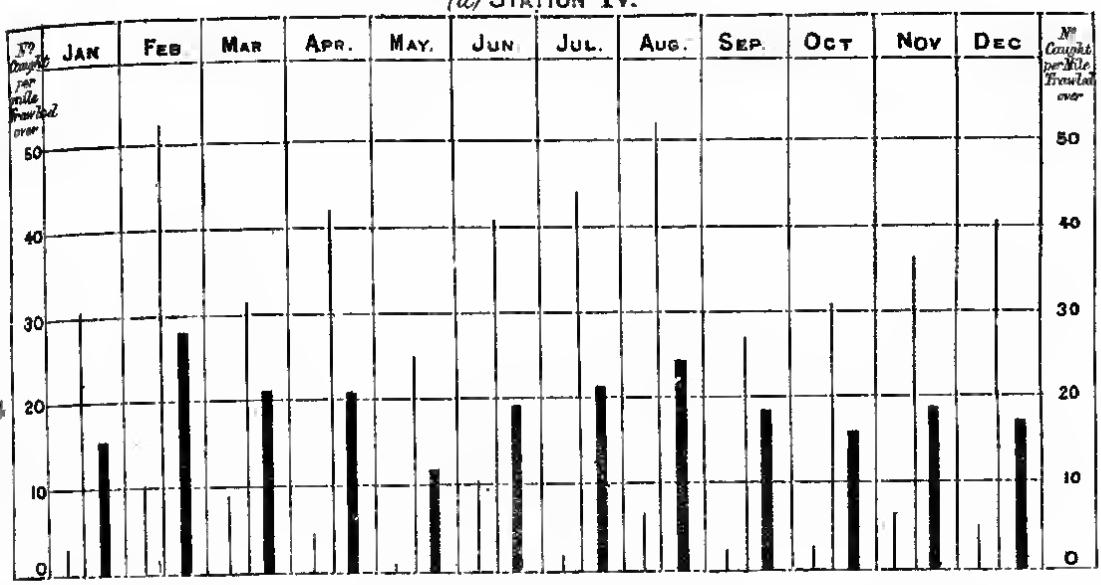


SHOWING THE AVERAGE MONTHLY NUMBER OF PLAICE TAKEN AT EACH STATION IN THE FIRTH OF FORTH (1889-1895) PER MILE TRAWLED OVER AND THE VARIATION BETWEEN THE HIGHEST AND LOWEST HAUL IN EACH MONTH.

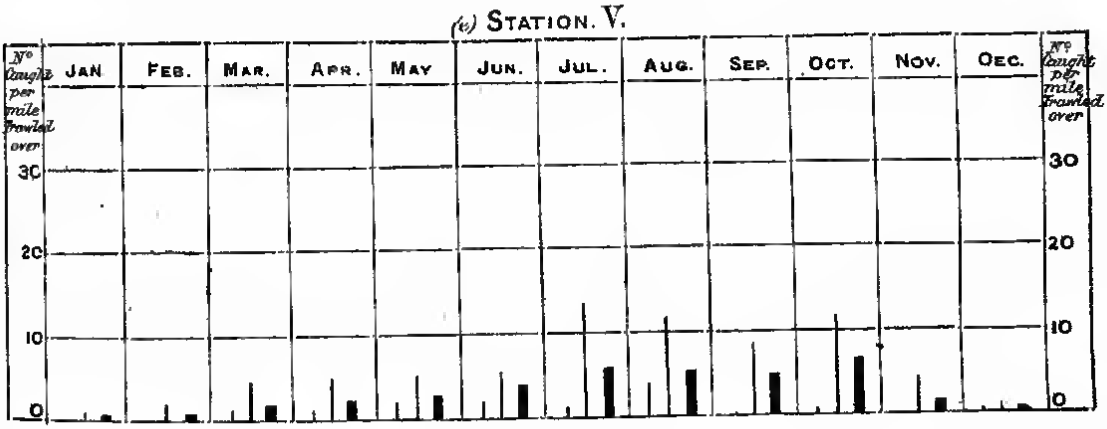
To illustrate answers to questions 1533 to 1537.

Thick Lines=Average 1889-1895. Thin Lines=Limits of Variation.

(d) STATION IV.



(e) STATION. V.



(f) STATION VI.

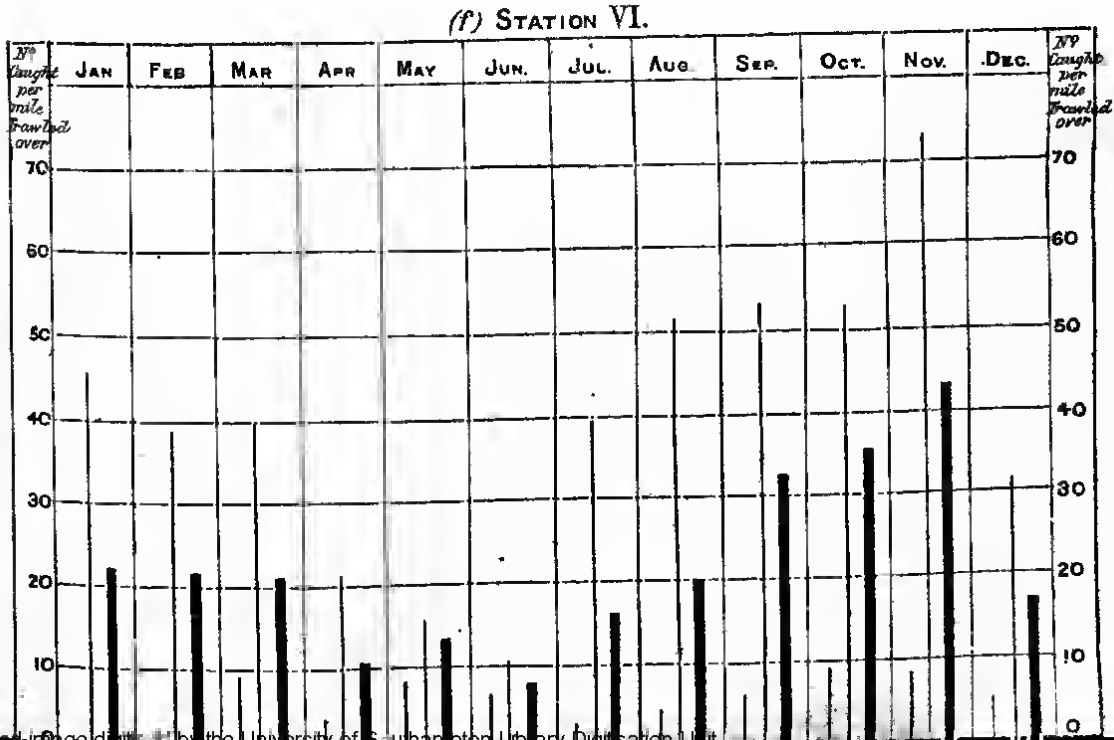


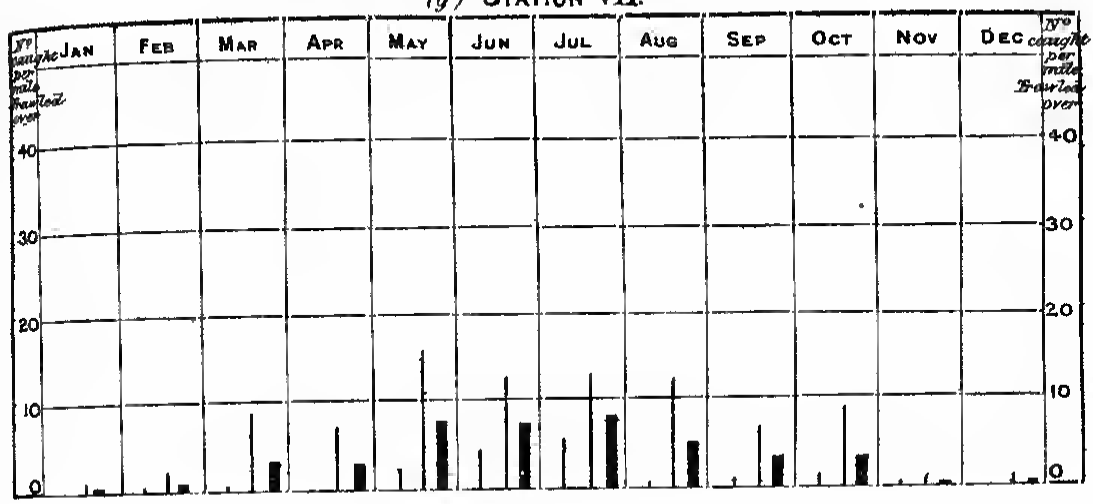
CHART II.

SHOWING THE AVERAGE MONTHLY NUMBER OF PLAICE TAKEN AT EACH STATION IN THE FIRTH OF FORTH (1889-1895) PER MILE TRAWLED OVER AND THE VARIATION BETWEEN THE HIGHEST AND LOWEST HAUL IN EACH MONTH.

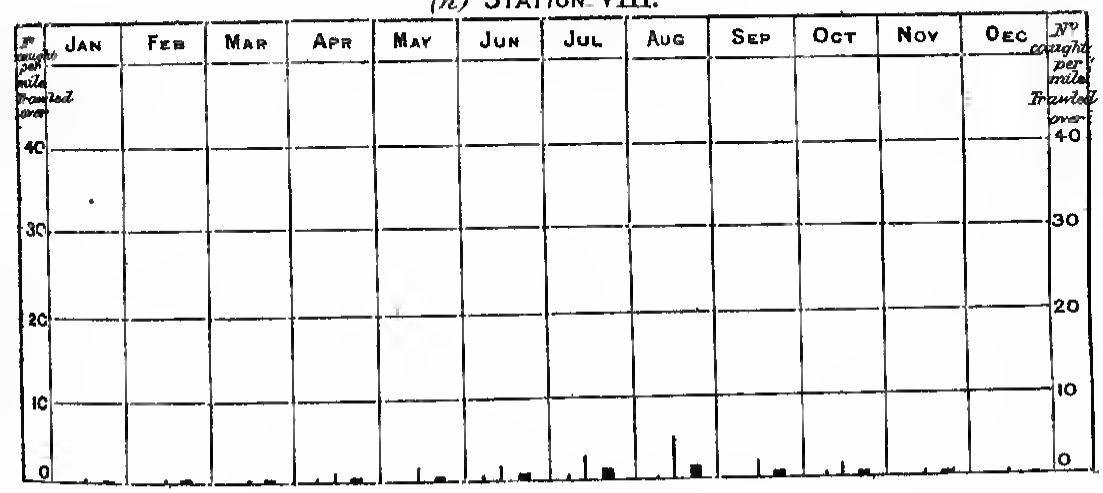
To illustrate answers to questions 1533 to 1537.

Thick Lines-Average 1889-1895. Thin Lines-Limits of Variation.

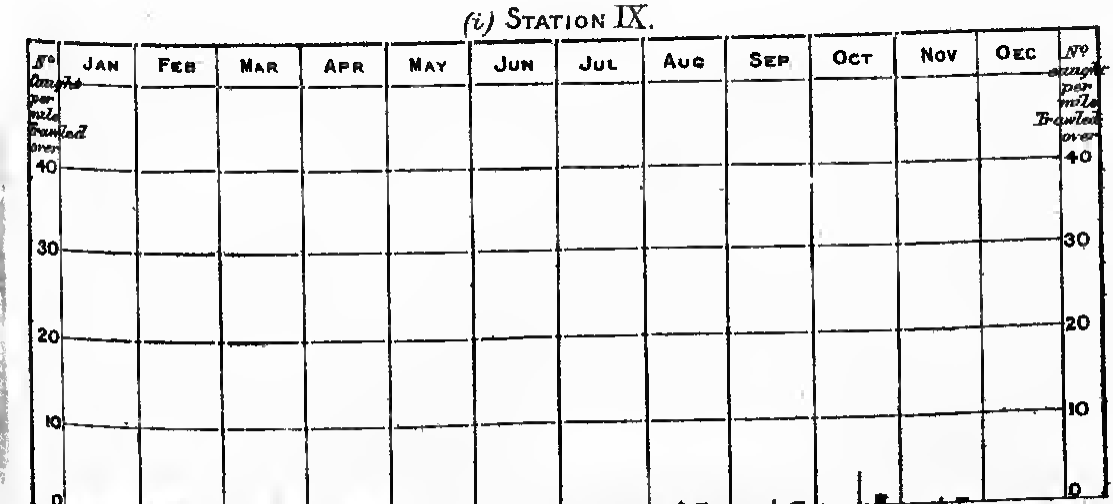
(g) STATION VII.



(h) STATION VIII.



(i) STATION IX.



E. Weller & Graham Ltd Litho London

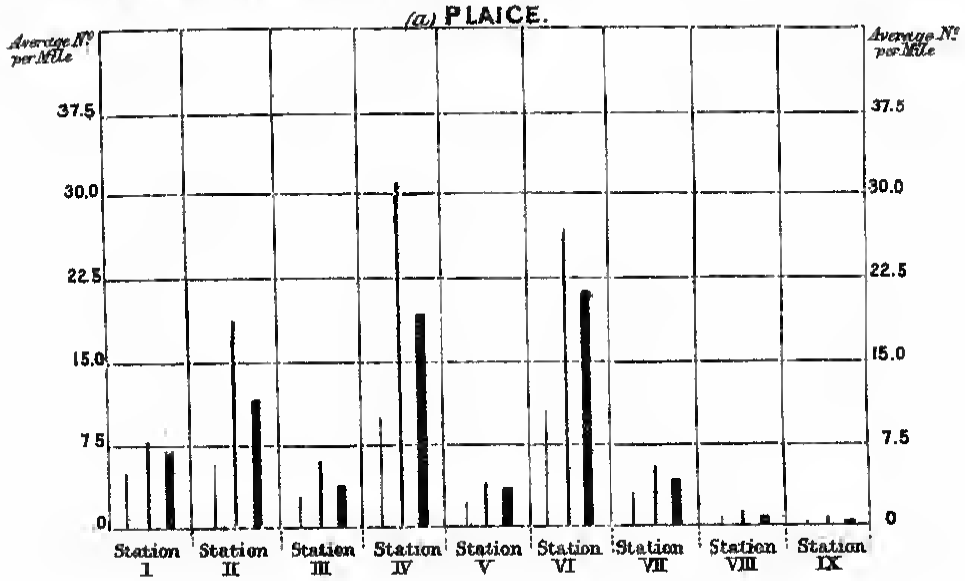
CHART III.

SHOWING THE AVERAGE ANNUAL NUMBER OF PLAICE, COMMON DABS, HADDOCK AND WHITING TAKEN AT EACH STATION IN THE FIRTH OF FORTH (1889–1895) PER MILE TRAWLED OVER AND THE VARIATION BETWEEN THE HIGHEST AND LOWEST QUANTITY TAKEN IN ANY YEAR.

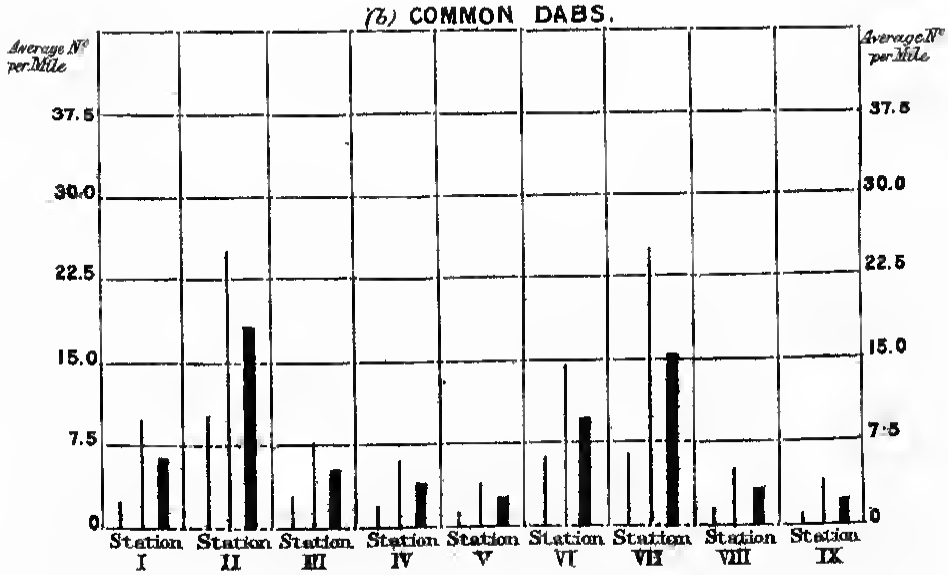
(To illustrate answer to question 1539)

Thick Lines – Average Number taken per Mile Trawled over during 1889-1895.
Thin Lines – Limits of Variation

(a) PLAICE.



(b) COMMON DABS.



1907.12 W.

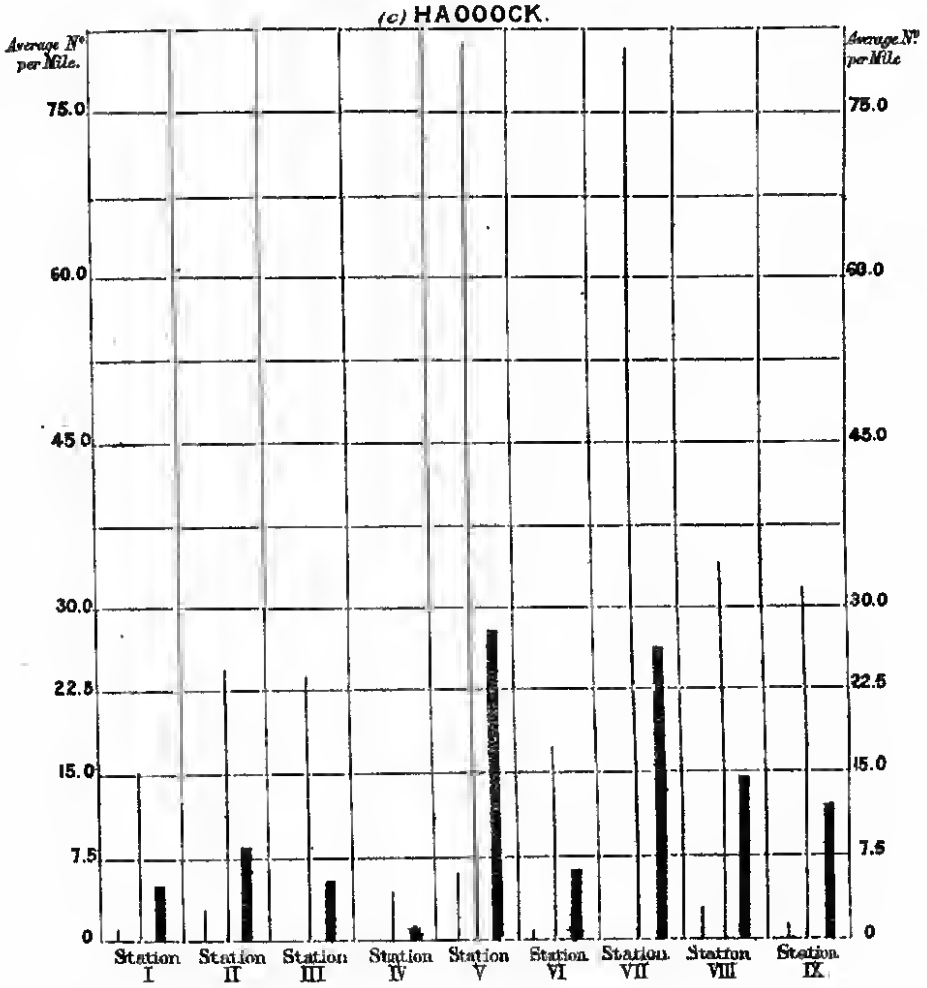
CHART III.

SHOWING THE AVERAGE ANNUAL NUMBER OF PLAICE, COMMON DABS, HADDOCK AND WHITING TAKEN AT EACH STATION IN THE FIRTH OF FORTH (1889-1895) PER MILE TRAWLED OVER AND THE VARIATION BETWEEN THE HIGHEST AND LOWEST QUANTITY TAKEN IN ANY YEAR.

(To illustrate answer to question 1539)

Thick lines, Average Number taken per Mile trawled over during 1889 1895.
Thin lines, - Limits of Variation

(c) HADDOCK.



(d) WHITING.

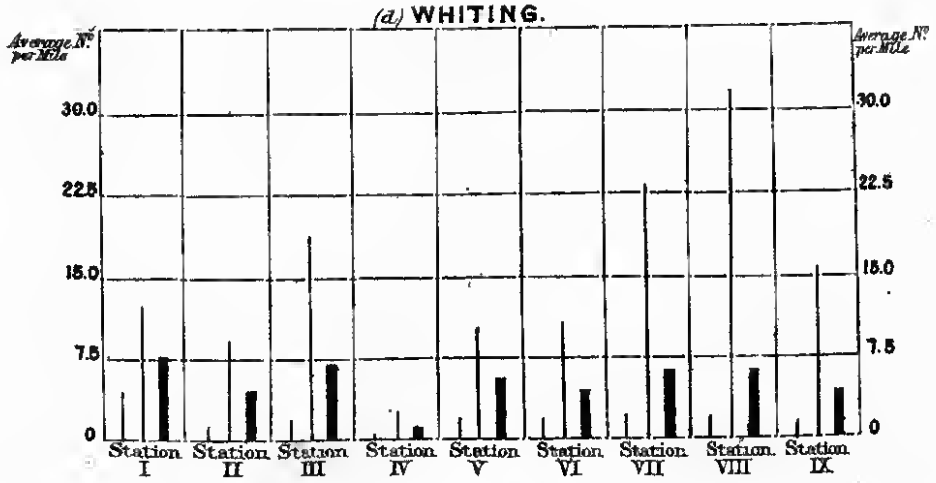
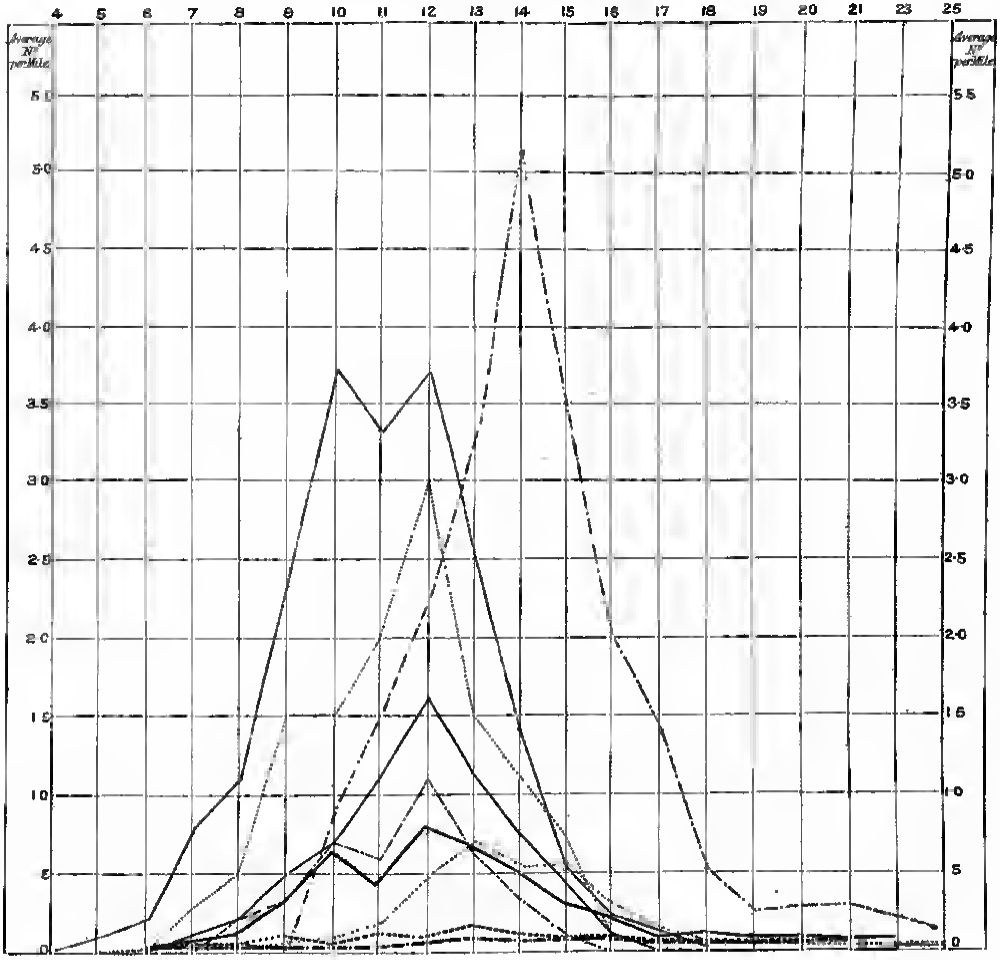


CHART IV.

SHOWING FOR EACH STATION THE AVERAGE NUMBER OF PLAICE TAKEN IN THE FIRTH OF FORTH (1889-1895) PER MILE TRAWLED OVER, GROUPED ACCORDING TO SIZE.

To illustrate answers to questions 1543 and 1574.



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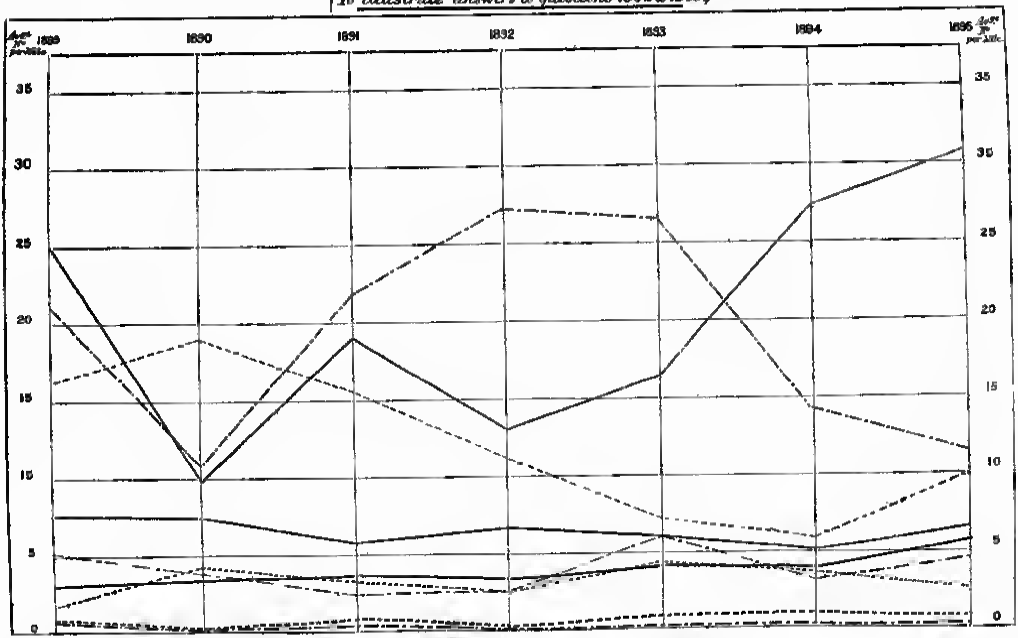
SHOWING FOR EACH STATION THE AVERAGE NUMBER OF FISH
TAKEN IN THE FIRTH OF FORTH, PER MILE TRAWLED OVER, IN EACH OF THE YEARS 1889 TO 1895

(a) PLAICE

(To illustrate answers to questions 1562 to 1566.)



SHOWING FOR EACH STATION THE AVERAGE NUMBER OF FISH
TAKEN IN THE FIRTH OF FORTH, PER MILE TRAWLED OVER, IN EACH OF THE YEARS 1889 TO 1895.

(5) COMMON DABS.

(To illustrate answers to questions 1562 to 1566)

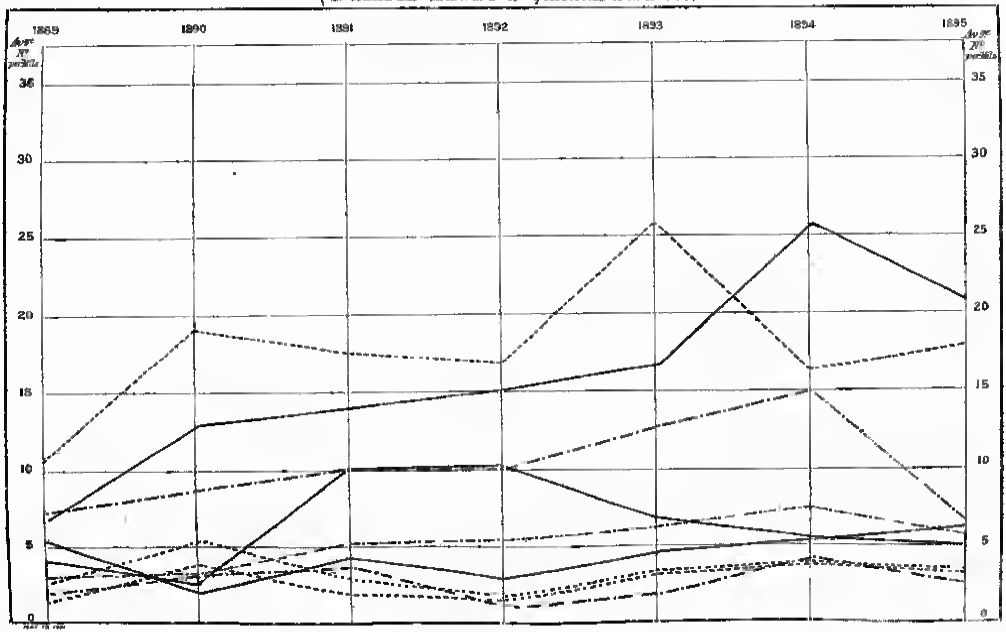


CHART V.

SHOWING FOR EACH STATION THE AVERAGE NUMBER OF FISH TAKEN IN THE FIRTH OF FORTH, PER MILE TRAWLED OVER, IN EACH OF THE YEARS 1889 TO 1895.

(c) HADDOCK.

(To illustrate answers to questions 1562 to 1566.)

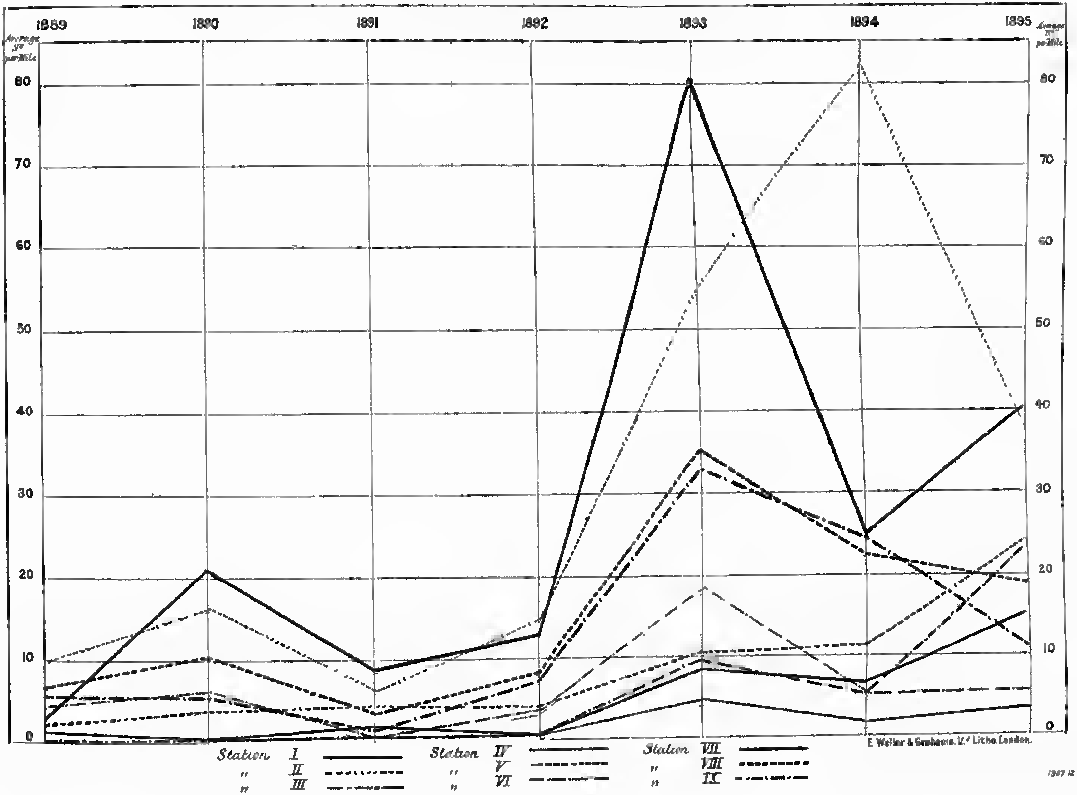
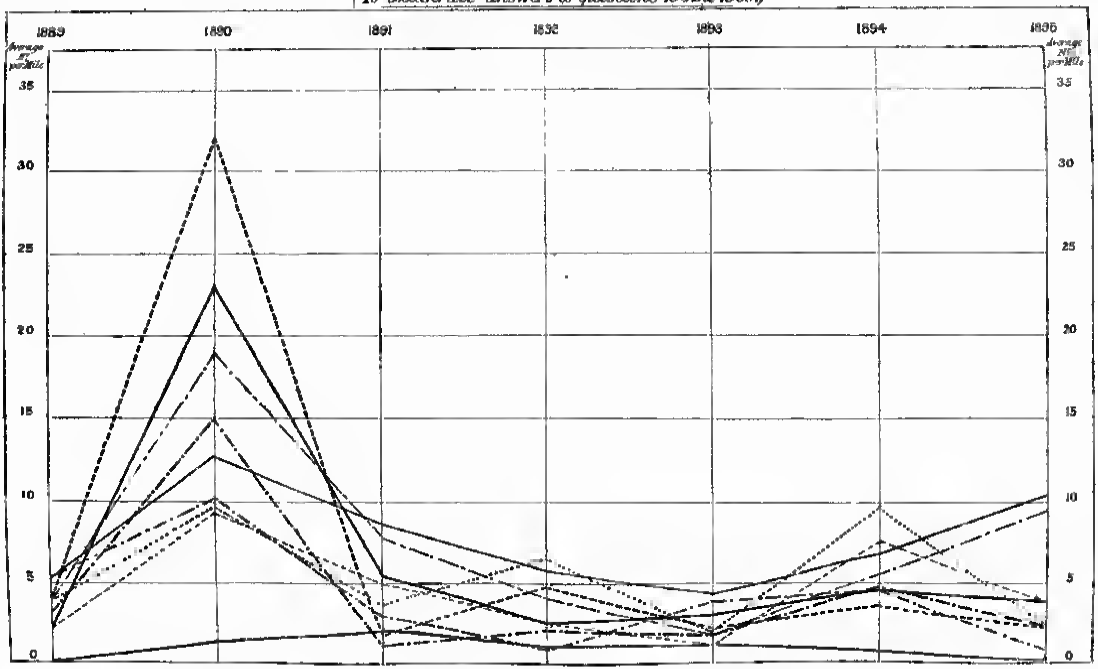


CHART V.

SHOWING FOR EACH STATION THE AVERAGE NUMBER OF FISH TAKEN IN THE FIRTH OF FORTH, PER MILE TRAWLED OVER, IN EACH OF THE YEARS 1889 TO 1895.

(2) WHITING

(To illustrate answers to questions 1562 to 1566.)



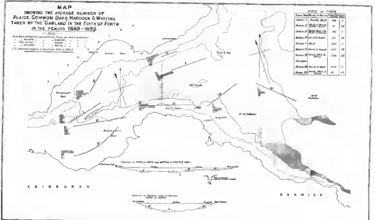
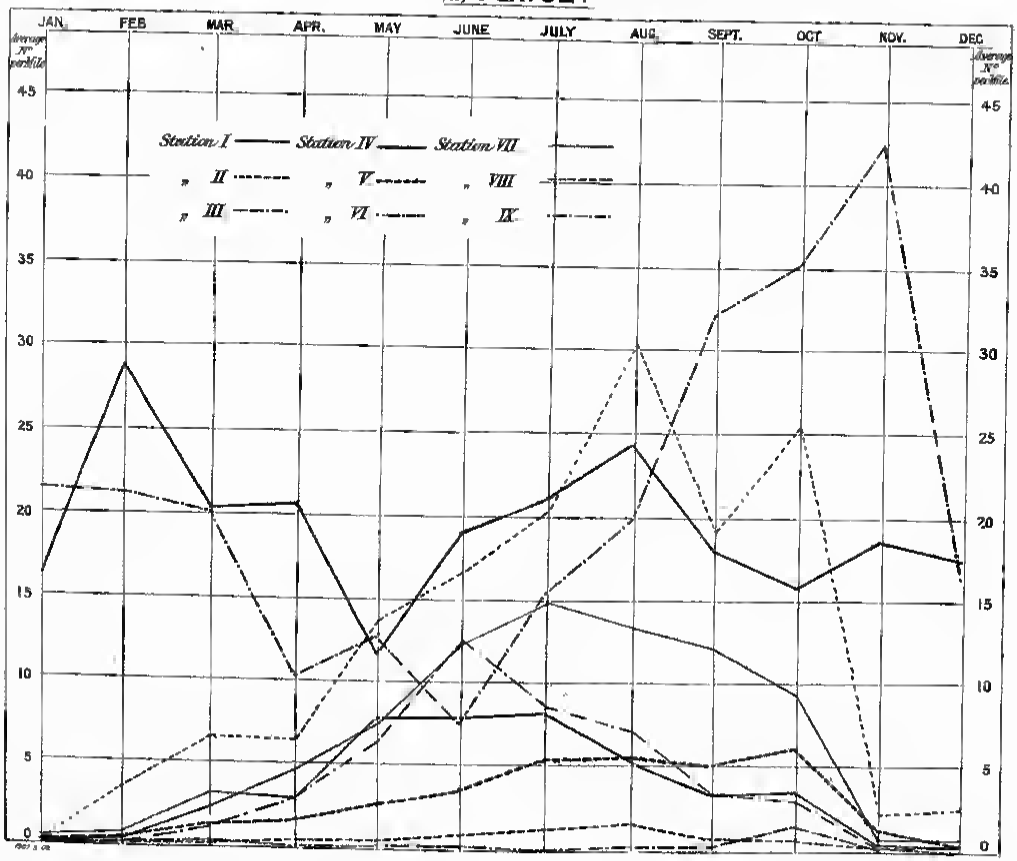


CHART VI.

SHOWING FOR EACH STATION THE AVERAGE NUMBER OF FISH TAKEN IN THE FIRTH OF FORTH PER MILE TRAWLED OVER IN EACH MONTH (1888-1895)

(To illustrate answers to questions 1566 to 1573)

(a) PLAICE.



E. Weller & Grahame, Ltd Litho Leighton.

CHART VI.

SHOWING FOR EACH STATION THE AVERAGE NUMBER OF FISH TAKEN IN THE FIRTH OF FORTH PER MILE TRAWLED OVER IN EACH MONTH (1889–1895)

(To illustrate answers to questions 1566 to 1573)

(b) COMMON DABS.

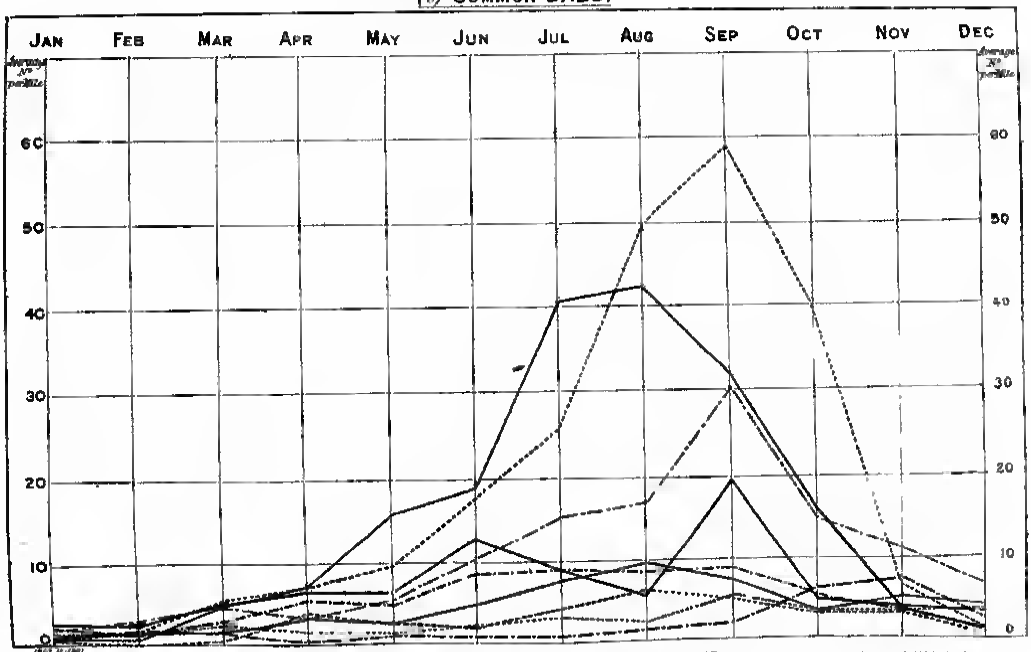


CHART VI.

SHOWING FOR EACH STATION THE AVERAGE NUMBER OF FISH TAKEN IN THE FIRTH OF FORTH PER MILE TRAWLED OVER, IN EACH MONTH (1889–1895)

(To illustrate answers to questions 1566 to 1573)

(c) HADDOCK.

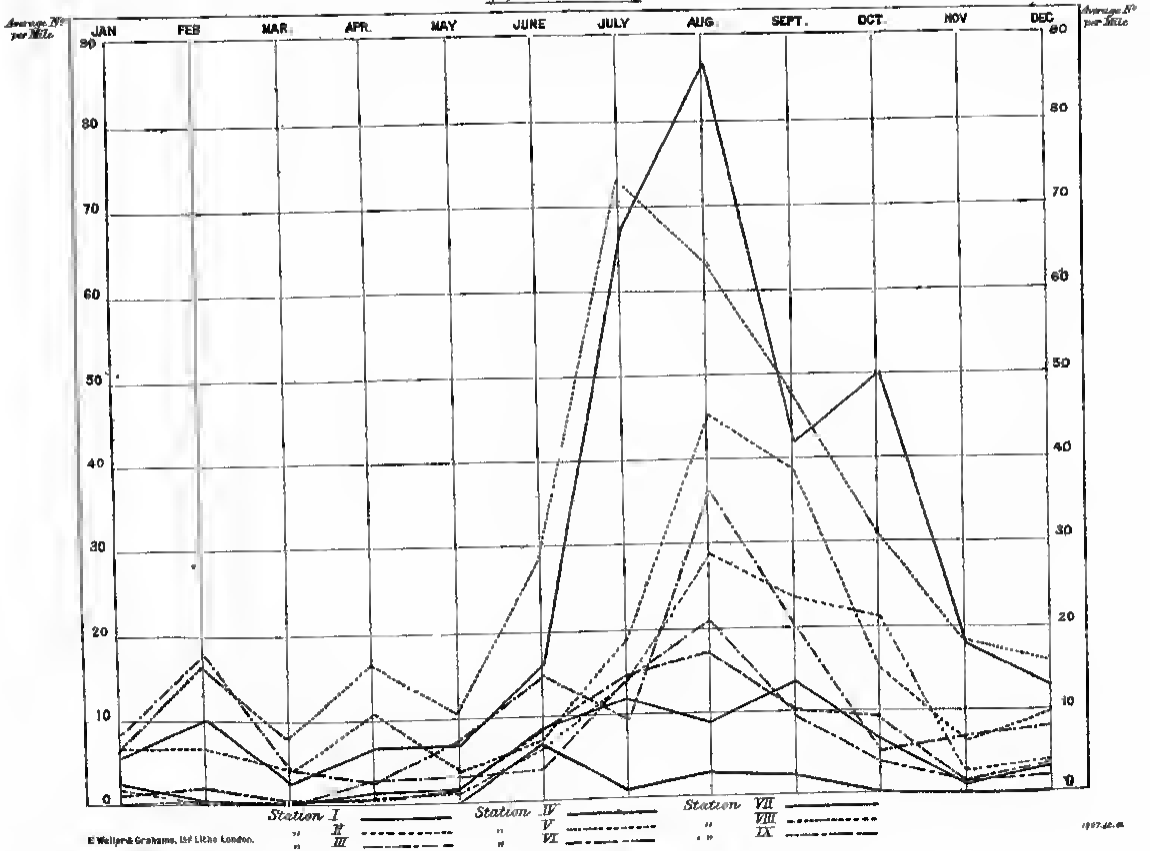


Chart VI.

Showing for each station the Average Number of Fish taken in the Firth of Forth per mile trawled over in each month (1883–1895)

(To illustrate answers to questions 1566 to 1573)

(a) Whiting.

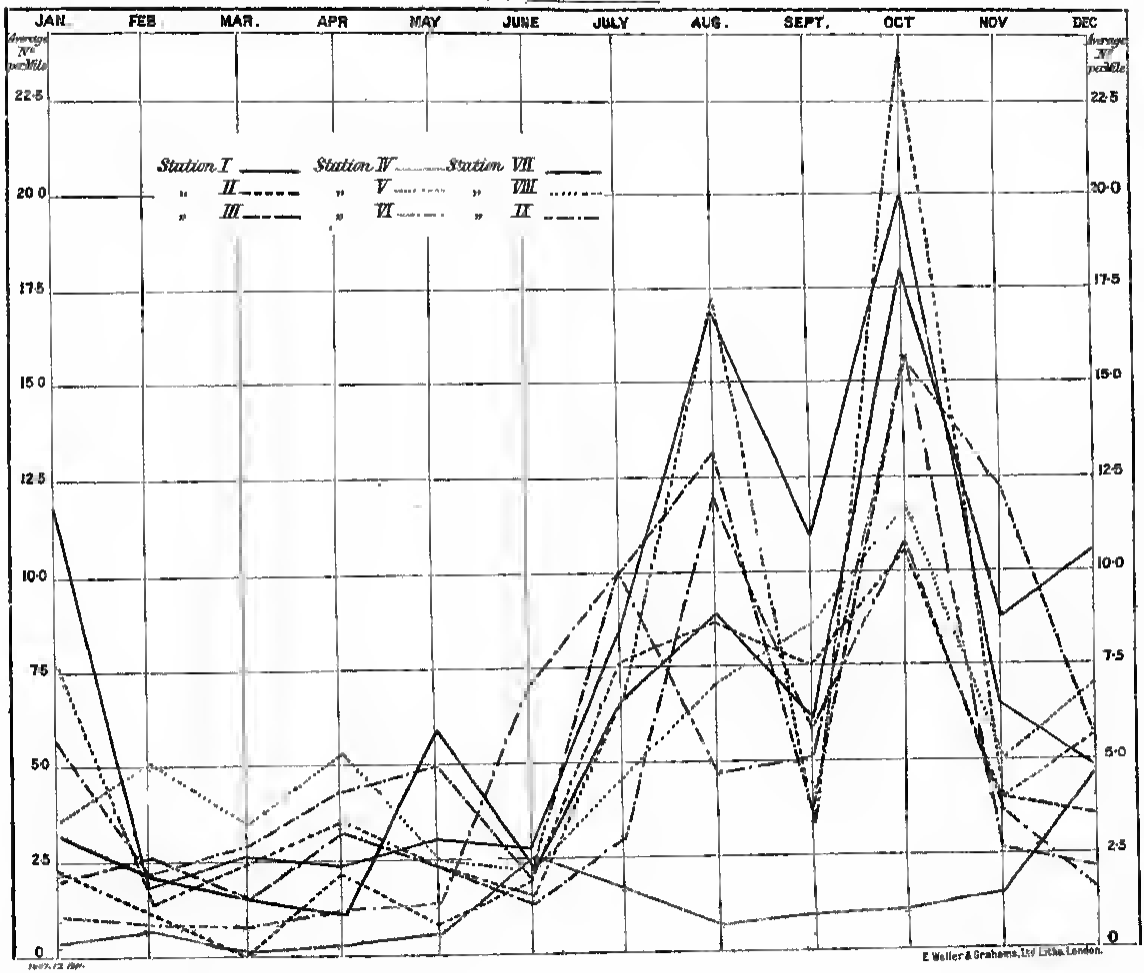
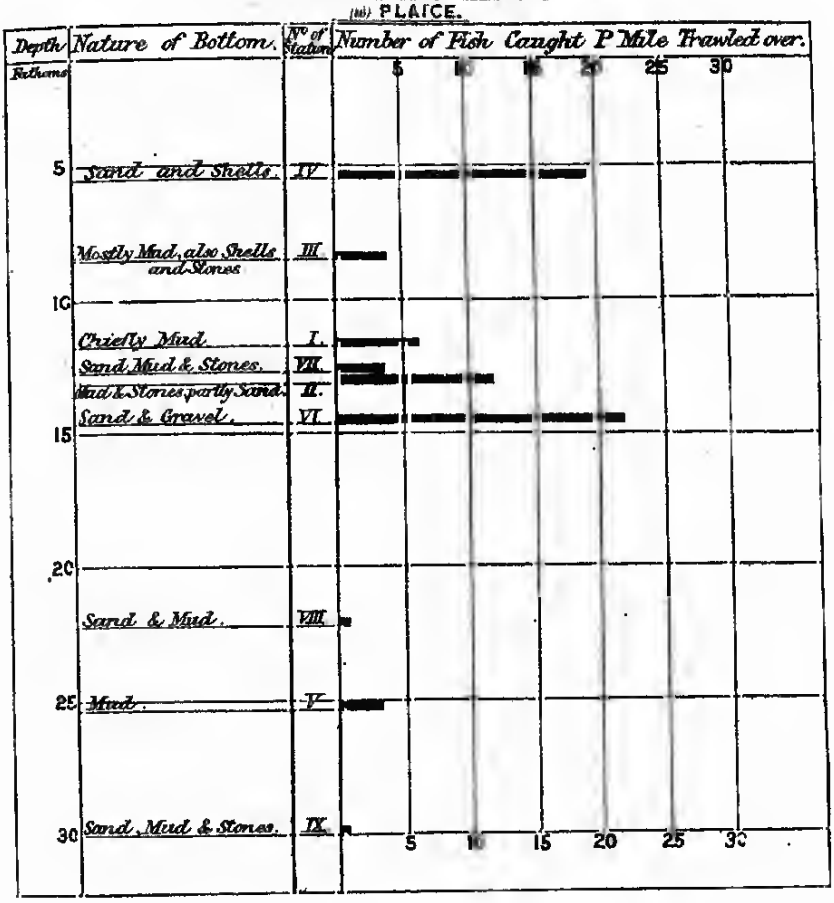


CHART VII. SHOWING THE

ABUNDANCE OF FISH CAUGHT IN THE FIRTH OF FORTH (1889–1895)
IN RELATION TO DEPTH AND NATURE OF BOTTOM.

(To illustrate answer to question 4575.)

(a) PLAICE.



(b) COMMON DABS.

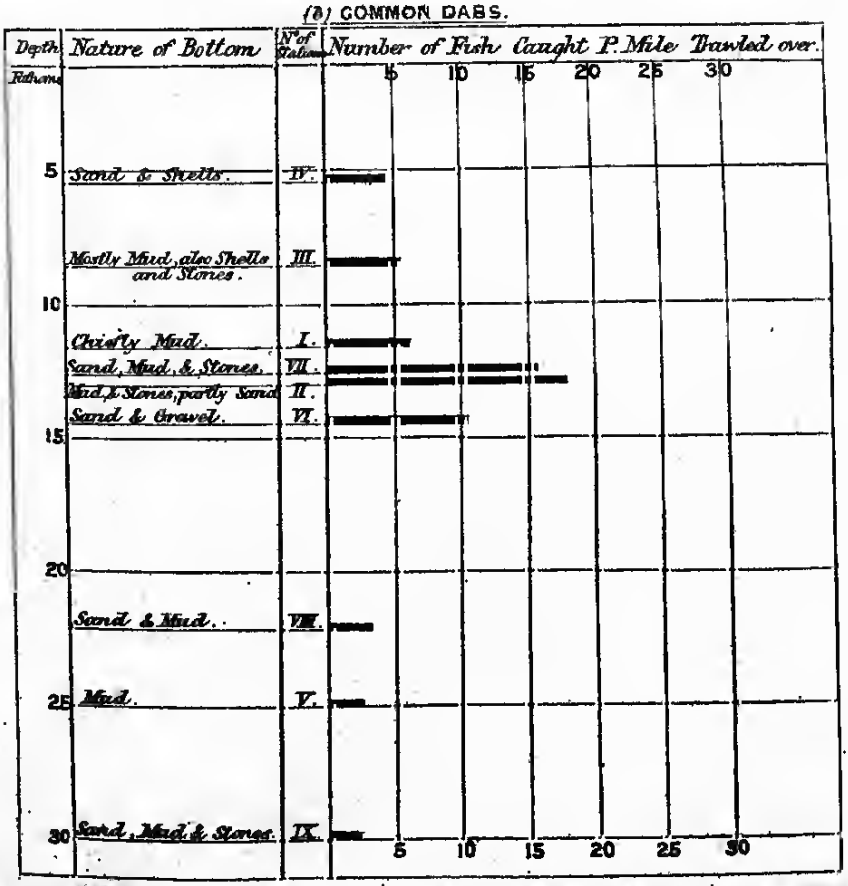
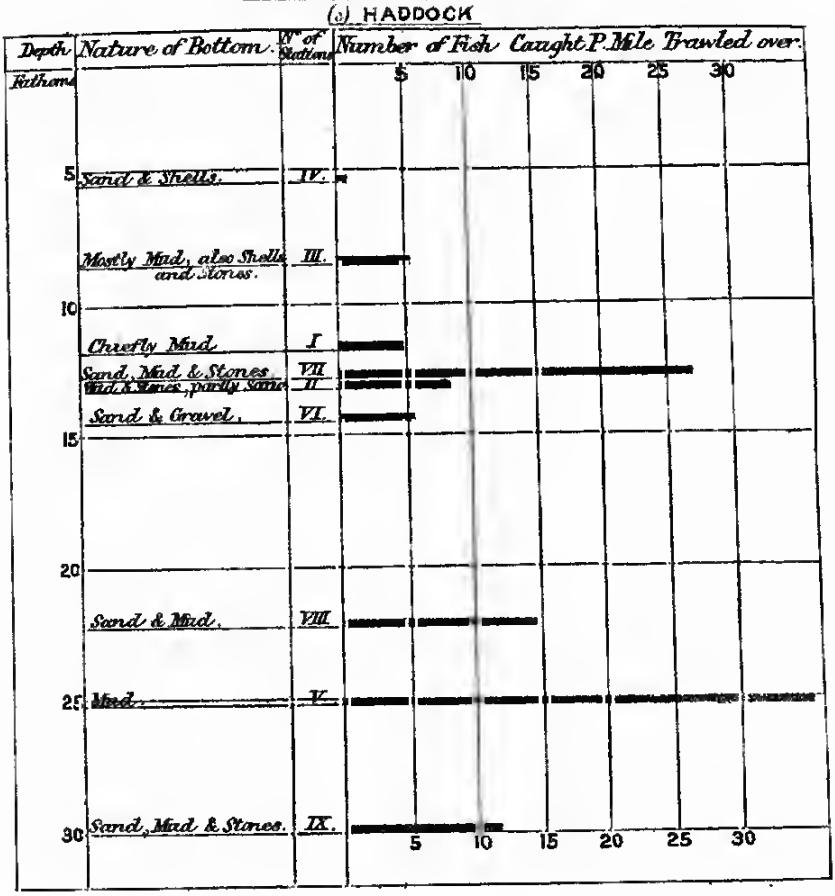


CHART VII SHOWING THE

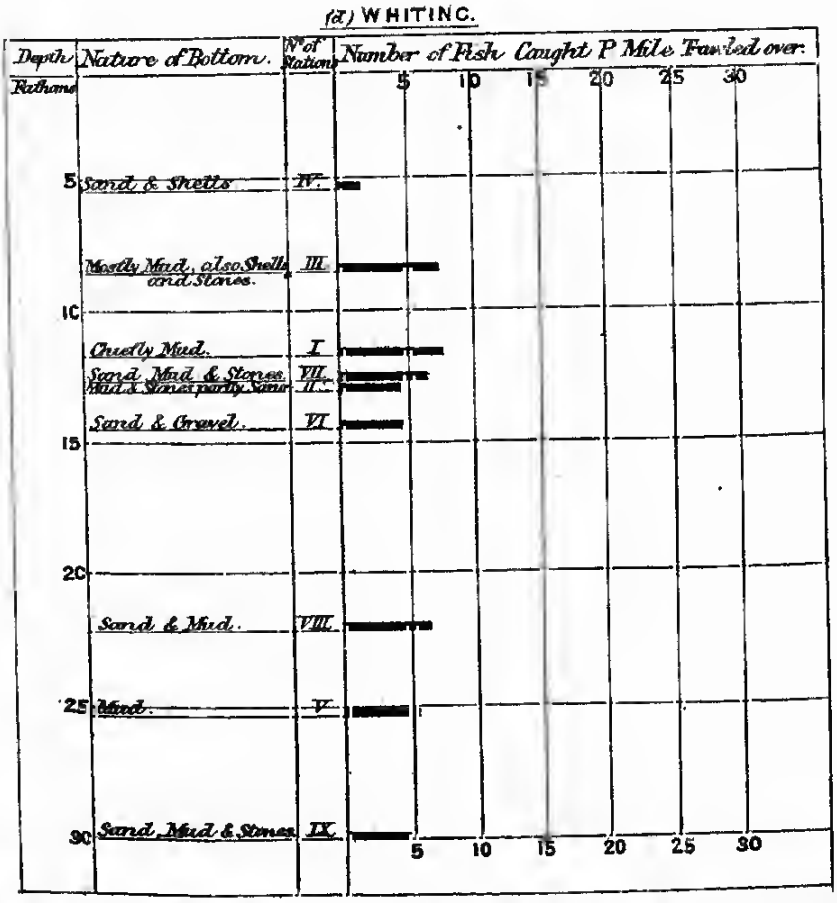
ABUNDANCE OF FISH CAUGHT IN THE FIRTH OF FORTH (1889-1895)
IN RELATION TO DEPTH AND NATURE OF BOTTOM. *(Continued.)*

(To illustrate answer to question 1515.)

(c) HADDOCK



(d) WHITING.



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